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ACTION OF SOME FUNGICIDES ON THE CITRUS-CANKER ORGANISM

A PROGRESS REPORT

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Experiments to determine the possibility of control by spraying methods of the bacterial disease, citrus canker, were undertaken by the writer in 1917. In developing this work it became desirable to understand more in detail the action of certain fungicides against *Pseudomonas citri* Hasse, the cause of the disease. Experiments were therefore undertaken to determine the toxic action of the common fungicides by the methods proposed by Anderson and McClintic[2] for obtaining the phenol coefficient of disinfectants.

A paper by Jehle[3] has already presented experiments upon the action of disinfectants on *Pseudomonas citri*. Jehle's tests were made by means of Hill's method, the glass-rod method, the platinum-loop method, and the filter-paper method. His work

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[2] Anderson, John F., and McClintic, Thomas B., Method of standardizing disinfectants with and without organic matter, Bull. Hyg. Lab. 82 (1912).

[3] Jehle, R. A., Effect of disinfectants upon Bacterium citri, Quarterly Bull. States Plant Board Florida, No. 2, 2 (January, 1918) 112.

was found very helpful to the present writer's problems, but listed results with only such disinfectants as mercuric bichloride, lysol, formaldehyde, etc.; Bordeaux mixtures, lime sulphur, and Burgundy mixtures were not reported upon. Data upon these last-mentioned fungicides were expected to be of value in our control problems, and tests with them were therefore begun. The method of Anderson and McClintic seemed to be the simplest and most desirable for this work. The following is a presentation of data obtained from these experiments:

BRIEF RÉSUMÉ OF METHODS OF ANDERSON AND McCLINTIC

Methods were devised by these investigators to test disinfectants both in the presence and in the absence of organic matter, using a standardized culture of *Bacillus typhosus*. In the work reported in the present paper, *Pseudomonas citri* of course was used for the tests. Since the choice of the organic matter in their methods was entirely empirical, it would seem that the tests in the absence of organic matter were most desirable for this problem. In either case the results in the present tests are for the most part comparative and cannot be considered as directly applicable.

The tests without organic material were made by exposing a carefully measured volume of a standardized culture of *Pseudomonas citri* to various dilutions of the disinfectants. Each dilution of each disinfectant was tested for periods of $2\frac{1}{2}$, 5, $7\frac{1}{2}$, 10, $12\frac{1}{2}$, and 15 minutes. The standardized culture in our experiments was a 3-day-old culture of *Pseudomonas citri* which had been previously transferred successively from 3-day-old bouillon cultures. The bouillon used was the standard nutrient beef peptone bouillon +1.5.

The culture to be used for the tests was first cooled to 20° C., and by means of sterile pipettes 0.1 cubic centimeter of this culture was then added to each of ten tubes, each containing 5 cubic centimeters of the dilutions of fungicides to be tested; these dilutions were also cooled and maintained at 20° C. The seeding tubes were then rotated to distribute the organisms throughout the disinfectant, and at the end of the periods of exposure one loopful of the mixed disinfectant and culture was removed by means of carefully standardized 3-millimeter platinum loops, flamed of course. The loopful of inoculated fungicide was then immediately transferred to a tube of nutrient beef bouillon +1.5; the killing of the canker bacteria was indicated by the absence of clouding in the bouillon tube. The presence of cloud-

iness in such a bouillon tube indicated the presence of citrus-canker organisms not killed by the fungicide. Since contaminations were possible, a test was made in all doubtful cases to show the identity of the clouding organism. The diagnosis for *Pseudomonas citri* is very simple and consists of a characteristic growth on potato plugs. Bouillon tubes which were of a suspicious character were therefore tested by this means to confirm the presence or absence of the canker bacteria.

Attention was mainly given to the principal fungicides which were found to be of possible use against canker. These were for the most part the standard fungicides which have been in use in the United States for the last decade. The results of these tests are best shown in the tabular form in which they are recorded in the card index; the tables follow:

TABLE 1.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of phenol.*

[Date of test, February 2, 1920; date of observation, February 5, 1920.]

Exposure.	Dilution expressed in percentage.									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Min. sec.										
2 30	+	—	—	—	—	—	—	—	—	—
5 00	+	—	—	—	—	—	—	—	—	—
7 30	+	—	—	—	—	—	[a] —	—	—	—
10 00	+	—	—	—	—	—	—	—	—	—
12 30	+	—	—	—	—	[a] —	—	—	—	—
15 00	+	—	—	—	—	—	—	—	—	—

[a] Tube tested for *P. citri*, February 5, 1920; negative, February 9, 1920.

The test was repeated using dilutions with water of 1 to 60, 1 to 80, 1 to 100, 1 to 120, and 1 to 140. All remained negative. Repeating the test with dilutions 1 to 80, 1 to 100, 1 to 120, 1 to 140, and 1 to 160, the last-mentioned dilution showed cloudiness in exposures for $2\frac{1}{2}$, 5, and $7\frac{1}{2}$ minutes, but remained negative in the longer exposures; that is, 10, $12\frac{1}{2}$, and 15 minutes. A repetition of the test gave positive results for dilutions of 1 to 140 for exposures of $2\frac{1}{2}$ and 5 minutes and for those of 1 to 160 exposed $2\frac{1}{2}$, 5, and $7\frac{1}{2}$ minutes. The results thus agree closely for this disinfectant. To summarize: 1 to 120 dilution of phenol killed the canker bacteria in all cases, at all the periods of exposure employed. This was in the entire absence of organic matter which might precipitate or otherwise neutralize the value of the disinfectant; thus a 1 to 100 dilution would be considered more certain of entire disinfection.

Compared with *Bacillus typhosus, Pseudomonas citri* is very slightly more resistant to disinfectants, or to phenol at least, according to these tests. The results of Anderson and McClintic with *B. typhosus* and these with *P. citri* are not directly comparable, however, since a 3-day-old culture was used for our tests, while Anderson and McClintic used a 24-hour culture of *B. typhosus* in their work.

TABLE 2.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of mercuric bichloride.*

[Date of test, February 5, 1920; date of observation, February 7, 1920.]

Exposure.	Dilution.									
	1 to 1,000,000.	1 to 500,000.	1 to 200,000.	1 to 100,000.	1 to 50,000.	1 to 20,000.	1 to 10,000.	1 to 5,000.	1 to 2,000.	1 to 1,000.
Min. *sec.*										
2 30	+	+	+	[a]+	—	—	—	—	—	—
5 00	+	+	+	+	—	—	—	—	—	—
7 30	+	+	+	+	—	—	—	—	—	—
10 00	+	+	+	+	—	—	—	—	—	—
12 30	+	+	+	+	—	—	—	—	—	—
15 00	+	+	[a]+	+	—	—	—	—	—	—

[a] Tube tested for *P. citri*, February 7; positive, February 8.

A previous test had been made with dilutions up to 1 to 20,000, all such dilutions giving negative results. Two subsequent tests with dilutions of 1 to 20,000, 1 to 50,000, 1 to 80,000, 1 to 90,000, and 1 to 100,000 gave negative results with the 1 to 20,000; exposures for $2\frac{1}{2}$ and 5 minutes in a dilution of 1 to 50,000 were positive in one case while the longer exposures were negative. In the other case all exposures to a dilution of 1 to 50,000 were positive; in both cases all exposures to dilutions of 1 to 80,000, 1 to 90,000, and 1 to 100,000 resulted positively. Apparently, therefore, a 1 to 20,000 dilution of mercuric bichloride is the weakest dilution possible in the case of this disinfectant in order to secure safely bactericidal action.

A preliminary test having given the rough limits for this disinfectant, the two tests shown in Table 3 were tried, and they showed very close agreement. A fourth test resulted negatively for all the periods of exposure to the 1 to 300 dilution; 1 to 400 dilution was positive at $2\frac{1}{2}$ and 5 minutes exposure, but at longer exposures was negative; all of the 1 to 500 and 1 to 600 dilutions, at all periods of exposure, were positive. There-

fore, 1 to 300 seems to be the most dilute solution possible for this disinfectant.

TABLE 3.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of Liquor cresolis compositus.*

Exposure.	Dilution.								
	1 to 400.	1 to 300.	1 to 200.	1 to 100.	1 to 600.	1 to 500.	1 to 400.	1 to 300.	1 to 200.
	Tested, February 7, 1920; observed, February 10, 1920.				Tested, April 28, 1920; observed, April 30, 1920.				
Min. sec.									
2 30	+	—	—	—	+	+	+	—	—
5 00	—	—	—	—	+	+	—	—	—
7 30	—	—	—	—	+	—	—	—	—
10 00	—	—	—	—	+	—	—	—	—
12 30	—	—	—	—	—	—	—	—	—
15 00	—	—	—	—	—	—	—	—	—

The kerosene emulsion, the tests of which are reported in Table 4, is a mixture suggested by previous experience for possible use as a disinfectant in canker-control work, also operating as a contact insecticide against scale insects which often become serious on citrus trees following copper sprays. The stock emulsion was prepared by adding 3 parts of kerosene to 1 of *Liquor cresolis compositus*. In a 1 to 50 mixture of this stock solution with water, the *Liquor cresolis compositus* would then be at a dilution of 1 to 200 parts of water.

TABLE 4.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of kerosene stock emulsion.*

[Date of test, February 5, 1920; date of observation, February 8, 1920.]

Exposure.	Dilution.									
	1 to 90.	1 to 85.	1 to 80.	1 to 75.	1 to 70.	1 to 65.	1 to 60.	1 to 55.	1 to 50.	1 to 45.
Min. sec.										
2 30	+	+	+	+	+	+	[a]+	—	—	[b]—
5 00	+	+	+	+	+	—	—	[c]—	—	—
7 30	+	+	+	—	—	—	[b]—	—	—	—
10 00	—	—	—	—	—	—	—	[b]—	—	—
12 30	—	—	—	—	—	—	—	—	—	[b]—
15 00	—	—	—	—	—	—	[c]—	—	—	—

[a] Tube tested for *P. citri*, February 7; positive for *P. citri*, February 8.
[b] Tube tested for *P. citri*, February 7; negative for *P. citri*, February 8.
[c] Tube tested for *P. citri*, February 8; negative for *P. citri*, February 11.

One other test was in such close agreement with the results shown in Table 4 that no further repetitions were made. A 1 to 50 dilution of this emulsion was used in the field. Such a dilution, according to these data, would seem to be entirely safe in the absence of any organic matter which would precipitate or otherwise neutralize the action of the disinfectant.

TABLE 5.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of formalin.*

[Date of test, February 3, 1920; date of observation, February 6, 1920.]

Exposure.	Dilution.									
	1 to 200.	1 to 180.	1 to 160.	1 to 140.	1 to 120.	1 to 100.	1 to 80.	1 to 60.	1 to 40.	1 to 20.
Min. sec.										
2 30	+	+	+	+	+	+	[a]+	+	+	−
5 00	+	+	+	+	+	+	+	+	−	−
7 30	+	+	+	+	+	[a]+	+	−	−	−
10 00	+	+	+	+	+	+	+	−	−	−
12 30	+	+	+	+	+	+	[b]−	−	−	−
15 00	+	+	+	+	[a]+	[c]+	−	−	−	−

[a] Exposure tested, February 5; positive, February 7.
[b] Exposure tested, February 5; negative, February 8.
[c] Exposure tested, February 7; positive, February 8.

Tests with formalin dilutions were made repeatedly in as much as there was a slight degree of variation in the results from exposures of dilutions of 1 to 40, 1 to 60, and 1 to 80. Formalin 1 to 100 at no period of exposure resulted in the killing of the canker bacteria. In one test all exposures at a dilution of 1 to 80 gave similar positive results, although in other tests the exposures for 10, 12½, and 15 minutes were negative. A dilution of 1 to 60 formalin in all tests failed to kill the canker bacteria in 2½ minutes; in one instance also it failed to kill after an exposure of 5 minutes. Two instances also occurred in which 1 to 40 formalin failed to kill at exposures of 2½ minutes although negative results were always obtained at 5-minute exposures. Such variations were probably due to some extent to variations in the content of the commercial formalin solutions used in the different tests. In any event it appears safe to say that, in orchard practice, no formalin solution more dilute than 1 to 20 is a safe disinfectant against the canker bacteria. In the writer's experience a dilution of 1 to 80 was the strongest that trees of *Citrus maxima, C. hystrix, C. nobilis,* or *C. sinensis* would stand without serious burning, under tropical conditions. Trees of *C. limonia* or *C. aurantifolia* are much more susceptible

to formalin burning, and a dilution of 1 to 120 was the strongest practicable without causing severe burning. The use of formalin as a spray in orchard work against citrus canker hardly seems feasible, therefore, unless in remote cases it is desirable to remove the leaves of the tree.

TABLE 6.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of lime-sulphur solution.*[a]

[Date of test, February 7, 1920; date of observation, February 9, 1920.]

Exposure.	Dilution.									
	1 to 500,000.	1 to 200,000.	1 to 100,000.	1 to 50,000.	1 to 20,000.	1 to 10,000.	1 to 5,000.	1 to 2,000.	1 to 1,000.	1 to 500.
Min. sec.										
2 30	+	+	+	+	+	+	−	+	−	−
5 00	+	+	+	+	+	+	+	+	−	−
7 30	+	+	+	+	+	+	+	[b]+	−	−
10 00	+	+	+	+	+	+	+	+	−	−
12 30	+	+	+	+	+	+	+	+	−	−
15 00	+	+	+	+	+	+	+	[c]+	−	−

[a] The stock solution of lime sulphur employed had a density of 32° Beaumé.
[b] Tube tested for *P. citri*, February 11; positive, February 13.
[c] Tube tested for *P. citri*, February 9; positive, February 11.

Two preliminary tests were necessary with this fungicide in order to obtain the limits of its action against the canker bacteria. Table 6 gives the results of the third test. Two later tests to define more closely the action of lime-sulphur solution were not in close agreement. The fourth test showed a dilution of 1 to 1,500 killing the canker bacteria at all exposures, while the 1 to 1,750 gave such results only in the longer exposures of 12½ and 15 minutes. The fifth test showed dilutions of 1 to 1,250 and 1 to 1,500 to be positive at all periods of exposure; 1 to 1,000 was negative at all periods of exposure. It seems safe to regard a dilution of 1 to 1,000 lime sulphur as sufficiently strong to kill the canker bacteria in the absence of organic matter.

The use of lime sulphur in orchard practice is especially desirable, of course, because of its additional value against citrus scab, wither tip, and insects. It would seem much more desirable than formalin; the latter has been used extensively against canker in the past, and its use hardly seems warranted by these tests and the writer's field experience.

TABLE 7.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of copper sulphate.*

[Date of test, February 3, 1920; date of observation, February 5, 1920.]

Exposure.	Dilution.									
	1 to 50,000.	1 to 20,000.	1 to 10,000.	1 to 5,000.	1 to 2,000.	1 to 1,000.	1 to 500.	1 to 200.	1 to 100.	1 to 50.
Min. sec.										
2 30	+	+	+	+	+	[a]+	[a]+	—	—	—
5 00	+	+	+	+	—	—	—	—	—	—
7 30	+	+	+	—	—	—	[b]—	—	—	—
10 00	+	+	+	[b]—	—	—	—	—	—	—
12 30	+	+	+	—	—	—	—	—	—	—
15 00	+	+	+	—	—	—	—	—	—	—

[a] Tube tested for *P. citri*, February 5, 1920; positive, February 7, 1920.
[b] Tube tested for *P. citri*, February 5, 1920; negative, February 7, 1920.

The results with copper sulphate at more finely graduated dilutions could not be made to agree. In the five tests employed a dilution of 1 to 200 gave negative results at all lengths of exposure. A dilution of 1 to 500 was toxic to the canker bacteria at $2\frac{1}{2}$ minutes exposure in only one test. Exposures of 5, $7\frac{1}{2}$, 10, $12\frac{1}{2}$, and 15 minutes at the same dilution were negative in all tests. The dilutions of 1 to 1,000 and 1 to 2,000 were positive in all tests at $2\frac{1}{2}$ minutes, but varied for exposures of 5, $7\frac{1}{2}$, 10, $12\frac{1}{2}$, and 15 minutes. One to 5,000 was positive at all exposures in all tests. In view of the considerable variation in results for the five tests it is not safe to consider any dilution of copper sulphate above 1 to 200 or 1 to 300 as a disinfectant for *Pseudomonas citri*. This is of interest in view of the probable weak dilutions of copper salts which are made available by the weathering of Bordeaux mixture and other copper sprays upon trees, and seems to indicate that the toxic action of such copper sprays would have little value in preventing citrus-canker infection if dependent only on the soluble copper salts liberated upon the foliage.

Repetition of the tests with dilutions of Bordeaux 4–4–50 mixture was made eight times; the results show considerable variation in the bactericidal value of Bordeaux 4–4–50 mixtures. Tests were made which showed a killing action at as low a dilution as 5 per cent for a length of exposure of 5 minutes. More commonly, however, killing has only been obtained with

the lesser dilutions of Bordeaux 4–4–50 mixture, and then usually only for the longer periods of exposure.

TABLE 8.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of Bordeaux 4–4–50 mixture.*[a]

[Date of test, July 22, 1920; date of observation, July 25, 1920.]

Exposure.	Dilution expressed in percentage.									
	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
Min. sec.										
2 30	+	+	+	+	+	+	+	+	+	+
5 00	+	+	+	+	+	+	+	+	+	+
7 30	+	+	+	+	+	+	+	+	[b]+	—
10 00	+	+	+	+	+	+	[b]+	—	—	—
12 30	+	+	+	+	+	+	—	—	—	—
15 00	+	+	+	+	+	[b]+	—	[c]—	[c]—	—

[a] Bordeaux 4–4–50 mixture was prepared as nearly as possible as it is done in the field. Commercial quicklime and copper sulphate were used. In order to avoid contamination of the tests, however, autoclaved tap water was used in making up the mixtures.

[b] Tube tested for *P. citri*, July 24, 1920; positive, July 26, 1920.

[c] Tube tested for *P. citri*, July 24, 1920; negative, July 26, 1920.

Apparently the degree of impurities in the commercial lime and copper sulphate varies greatly and such variations are repeated in the toxic action of the Bordeaux mixture. In the eight tests made, Bordeaux 4–4–50 mixture, undiluted, at exposures of 15 or 20 minutes, resulted in the entire killing out of *Pseudomonas citri*. The tests indicate that in orchard practice the Bordeaux mixtures are far from being uniform in content and in bactericidal action.

For orchard use against citrus canker this mixture has an advantage over the disinfectants previously listed, in that it adheres to the foliage even in the most violent rains, and presumably affords some degree of bactericidal action as long as any of it is present on the leaf. Field tests in the Philippines and in Japan, as yet unpublished, support this statement. Bordeaux 4–4–50 mixture would therefore seem to be more desirable than the other germicides previously listed for use as a disinfectant spray in the eradication of citrus canker. Sterling[4] makes a similar statement of the action of Bordeaux mixture in Florida as follows:

> We have also noticed that where groves have been repeatedly sprayed with Bordeaux, even tho they are close to an affected grove, the chance of their becoming affected is considerably lessened, altho the Bordeaux does no good after the tree is once infected.

[4] Sterling, Frank, Eradication of citrus canker, Bull. Fla. Agr. Exp. Station 124 (1914) 53.

Sterling's observation would therefore seem to support the conclusion brought forward here; that is, that a spray of Bordeaux 4–4–50 mixture, because of its more lasting bactericidal properties in addition to its immediate killing capacity, is more valuable than a disinfectant which is washed off by the first rain or is evaporated soon after application.

In spraying tests in the field it had been suggested that the so-called neutral Bordeaux mixture might prove of greater value than Bordeaux 4–4–50 mixture. The term neutral Bordeaux mixture was used for a mixture in which the amount of lime added was just sufficient to precipitate all of the copper, with no excess. The reasoning followed in this suggestion apparently was that with an excess of lime, soluble copper salts would be available only after long weathering; with just the proper amount of lime to precipitate the copper entirely, with no excess, it seemed to follow that the soluble copper salts would be liberated more freely. Tests in the field with such a neutral Bordeaux mixture showed no advantage whatsoever over the Bordeaux 4–4–50 mixture; on the contrary, in the two-year trials in which the two mixtures were compared, a very slight advantage lay with the Bordeaux 4–4–50 mixture. Tests to compare the two mixtures by Anderson and McClintic's method were therefore made. The results are best shown in Table 9.

TABLE 9.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of neutral Bordeaux mixture.*[a]

[Date of test, August 13, 1920; date of observation, August 16, 1920.]

Exposure.	Dilution expressed in percentage.									
	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
Min. sec.										
2 30	[b]+	+	+	+	+	+	+	+	+	[b]+
5 00	+	+	+	+	+	+	+	+	+	+
7 30	+	+	+	+	+	+	+	+	+	+
10 00	+	+	+	+	+	+	+	+	+	+
12 30	+	+	+	+	+	+	+	+	+	+
15 00	+	+	+	+	+	+	+	+	[b]+	[b]+

[a] The neutral Bordeaux mixture was made up with autoclaved tap water to avoid contamination; otherwise the preparation was entirely similar to the mixtures as prepared in the field. The neutral point was determined as nearly as possible by litmus paper tests.

[b] Exposure tested for *P. citri*, August 16; positive, August 18.

Tests with this mixture were repeated seven times; four of the tests resulted entirely uniformly with no killing of the canker bacteria whatsoever. The other three showed killing at the

stronger dilutions for the longer periods of exposure. It seems probable, in the light of later tests, that killing was due, not to the copper compounds, but to a slight excess of lime resulting from an imperfect manufacture of "neutral" Bordeaux mixture. In any event the tests show that neutral Bordeaux mixture had little or no toxic action against the citrus-canker bacteria, in contrast to a more pronounced action exhibited by Bordeaux 4–4–50 mixture. Following out the suggestion from this, Bordeaux 4–6–50 mixture was tested. The results are presented in Table 10.

TABLE 10.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of Bordeaux 4–6–50 mixture.*

[Date of test, July 24, 1920; date of observation, July 29, 1920.]

Exposure.	Dilution expressed in percentage.									
	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
Min. *sec.*										
2 30	[a]+	—	—	—	—	—	—	—	—	[b]—
5 00	—	—	—	—	—	—	—	—	—	[b]—
7 30	—	—	—	—	—	—	—	—	—	—
10 00	—	—	—	—	—	—	—	—	—	[b]—
12 30	—	—	—	—	—	—	—	—	—	—
15 00	—	—	—	—	—	—	—	—	—	—

[a] Tested on potato, July 26; positive, July 29.

[b] Bouillon tested by inoculation with *P. citri*, July 26; positive, July 29. This shows that the medium was not toxic to the organism.

This test was made four times with closely agreeing results. The evidence in regard to Bordeaux mixtures, then, showed that neutral Bordeaux mixture was valueless as a toxic agent against *Pseudomonas citri;* that Bordeaux mixture 4–4–50 was of slightly stronger bactericidal action; and that Bordeaux 4–6–50 was much the strongest of the three preparations. It was believed at first that this was because of a different copper compound, formed in the presence of an excess of lime, from that formed by the use of lime sufficient to make only neutral Bordeaux mixture. Tables 11 and 12 yield evidence upon this hypothesis.

The results were entirely unexpected, but have been corroborated by frequent tests. Comparing the results with those obtained from copper sulphate it is apparent that of the two constituents of Bordeaux mixture, quicklime when freshly slaked has at least as great a bactericidal value as copper sulphate, if not a greater. According to these tests a 0.1 per cent

solution of freshly slaked lime has a complete killing effect against *Pseudomonas citri* in $2\frac{1}{2}$ minutes, in the absence of organic compounds. Copper sulphate under identical conditions required a 0.5 per cent solution to kill *Pseudomonas citri* entirely in $2\frac{1}{2}$ minutes.

TABLE 11.—*Results of exposures with 3-day-old culture of Pseudomonas citri dilutions of a solution of commercial quicklime in water. Stock lime solution, 4 pounds to 50 gallons water.*

[Date of test, August 13, 1920; date of observation, August 16, 1920.]

Exposure.	Dilution expressed in percentage.									
	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
Min. *sec.*										
2 30	—	—	—	—	—	—	—	[a]—	—	—
5 00	—	—	—	—	—	—	—	—	—	—
7 30	—	—	—	—	—	—	—	—	—	—
10 00	—	—	—	—	—	—	—	—	—	—
12 30	—	—	—	—	—	—	—	—	—	—
15 00	—	—	—	—	[a]—	—	—	—	—	—

[a] Exposure tested on potato, August 16; negative, August 18.

This test was repeated with more dilute solutions of lime, and the results are shown in Table 12.

TABLE 12.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of a solution of commercial quicklime in water.*

[Date of test, September 3, 1920; date of observation, September 6, 1920.]

Exposure.	Dilution expressed in percentage.[a]									
	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
Min. *sec.*										
2 30	+	+	+	+	+	+	+	+	—	—
5 00	+	+	+	+	+	+	+	—	—	—
7 30	+	+	+	+	+	—	—	—	—	—
10 00	+	+	+	+	—	—	—	—	—	—
12 30	+	+	+	—	—	—	—	—	—	—
15 00	+	+	+	—	—	—	—	—	—	—

[a] Percentages express the weight of quicklime in volume of water.

A number of tests with Burgundy mixture [5] were also made. Burgundy 3–3–50 mixture, in which sodium carbonate is very slightly in excess of the amount necessary to precipitate the

[5] Burgundy mixture is prepared by precipitating the copper from a copper sulphate solution with sodium carbonate.

copper, in most of the tests showed no bactericidal value whatsoever. In a few tests slight killing was effected with the undiluted mixture at the longer exposures. When the results with the Bordeaux mixtures made it apparent that it was excess of lime which contributed the bactericidal value, the Burgundy mixture was prepared with an excess of sodium carbonate. In a comparative test, Burgundy mixture 3–4–50 showed a stronger toxic action against *Pseudomonas citri* than did Burgundy mixture 3–3–50. The toxic action was far from being as complete as in the case of Bordeaux mixture 4–6–50, or even Bordeaux mixture 4–4–50.

A comparison of these results with copper sprays and with lime leads to the conclusion that in none of the copper precipitate sprays, where there is no excess of either of the precipitants, is there any bactericidal action. This, of course, on retrospection, was to be expected from a fungicide which consists of an insoluble precipitate in suspension.

The criticism of the value of these tests will be raised, that the fungicidal value of copper precipitate sprays depends upon the action of the products of metabolism of the fungus itself on the copper precipitate; these metabolism products liberate the copper in a soluble form which is then toxic to the fungus. It will be said then that, although the bacteria are not instantly killed in the foregoing copper precipitate tests, upon the tree their metabolism products will also liberate the copper from the copper precipitate as do the fungi, and that the bacterial cells would then be coagulated.

To prove or disprove this, organisms from a 3-day-old *Pseudomonas citri* culture were exposed to neutral Bordeaux mixture for 60 minutes. At the end of the exposure *P. citri* was easily recovered. *P. citri* from a 3-day-old culture was then inoculated into bouillon tubes containing .05 cubic centimeter of neutral Bordeaux mixture to 10 cubic centimeters of bouillon. Growth appeared as rapidly in the presence of the Bordeaux mixture as in the control tubes containing no *P. citri;* a copious ring characteristic of *P. citri* in vigorous cultures formed at the surfaces of all bouillon tubes, both in those containing neutral Bordeaux mixture and in the controls. The tests were repeated a number of times.

This is taken as showing that the metabolism products of *Pseudomonas citri* do not cause the liberation of copper from the copper precipitate formed in Bordeaux mixture, at least not

in amounts sufficient to prevent or even check growth. Further work is now being carried on upon this subject.

DISCUSSION OF RESULTS

A 1 to 100 solution of phenol, in the absence of organic substances, is entirely effective against *Pseudomonas citri* at an exposure of 2½ minutes. Mercuric bichloride at a dilution of 1 to 20,000 under the same conditions is also effective against *P. citri* at an exposure of 2½ minutes; *Liquor cresolis compositus,* at an exposure of the same length, will kill in a 1 to 300 solution; formalin, to kill under the same conditions, requires a 1 to 20 solution; an emulsion composed of *Liquor cresolis compositus* and kerosene is safely effective in a 1 to 50 dilution. Of the commercially used fungicides lime sulphur is effective at a dilution of 1 to 1,000 for an exposure of 2½ minutes; copper sulphate is a safe bactericide only at a dilution of 1 to 200 for the same length of exposure; neutral Bordeaux mixture has no bactericidal effect whatsoever even at exposures of 30 and 60 minutes; Bordeaux 4–4–50 mixture, undiluted, is not a safe bactericide against *P. citri* at an exposure of 2½ minutes, but at 15 minutes' exposure it was effective against *P. citri* in nearly all of the tests; Bordeaux mixture 4–6–50, a mixture in which the lime was considerably in excess, showed toxic action in 2½ minutes when diluted with 4 parts of water; unslaked lime (commercial) at a dilution of 1 to 1,000 was effective against *P. citri* for the same length of exposure. Burgundy mixture 3–3–50 was entirely effective against *P. citri,* and Burgundy 3–4–50 mixture showed toxic action only at the longer exposures, even when undiluted.

The application of these results in the orchard should be somewhat as follows: For disinfection of clothing, implements, etc., in canker-eradication work, mercuric bichloride as used, at a dilution of 1 to 2,000, is the most effective and, probably, under most conditions is the cheapest. In eradication work the occasion sometimes arises where, an infected tree being found and burned, it is desirable to spray the surrounding trees to kill any of the canker organisms which may exist on the surfaces of their foliage. In such cases formalin 1 to 100 has frequently been used in the past. The use of formalin 1 to 100 was recommended by Kellerman [6] in the Yearbook of the United States Department of Agriculture. According to these tests formalin

[6] Kellerman, K. F., Cooperative work for eradicating citrus canker, Yearbook U. S. Dept. Agr. for 1916 (1917) 270.

1 to 100 is entirely valueless, and spraying with such a solution might even serve to disseminate the canker bacteria and spread the disease. The present results would indicate that formalin, to be of any value, would have to be at a concentration of 1 to 20. The use of formalin at a dilution of 1 to 20, or even 1 to 40 or 1 to 60, is impossible on citrus trees, in as much as formalin at such dilutions burns the foliage. Mercuric bichloride at a dilution of 1 to 2,000 has also been known to burn the foliage of citrus trees. It would seem desirable, therefore, to use mercuric bichloride at a dilution of 1 to 5,000 or 1 to 10,000. Such dilutions, as shown by these tests, are effective as bactericides against *Pseudomonas citri.* Commercial unslaked lime at a dilution of 1 to 500, as shown by these tests, would be effective against the canker bacteria; would have a more lasting effect than such disinfectants as lysol, formalin, etc.; and would be cheap and entirely safe for use on citrus trees.

In orchard practice in countries where citrus canker is already generally prevalent and where spraying may be employed as an annual preventive measure, it may be desirable to combine such spraying measures with preventive measures against other diseases or insects. In such a case if a fungicide only is used, Bordeaux 4–6–50 would seem to be the only mixture having, at the same time, a proven fungicidal value and a bactericidal action against *Pseudomonas citri.* It has already been shown in field experiments not yet published that Bordeaux mixture 4–4–50 is more effective against citrus canker than neutral Bordeaux mixture. These field data in a way corroborate the present data in indicating that Bordeaux 4–6–50 would be the most effective Bordeaux mixture for use against citrus canker.

In case a contact insecticide were desirable at the same time as a spray against citrus canker, lime sulphur, as shown by the foregoing tests, would be effective at any of the dilutions desirable for insecticidal use.

The tests presented here suggest many possibilities in connection with citrus-canker control by spraying. It is very evident that the bactericidal action exhibited by Bordeaux and by Burgundy mixtures as used in orchard and field work is due to the excess of the negative ion rather than to the copper. It was shown in the tests with copper sulphate that as strong a concentration as 1 to 200 was necessary to exert any effect upon *P. citri* in 2½ minutes. Consideration of the conditions incident to the weathering of Bordeaux mixture on the foliage leads to the conclusion that rarely or not at all will such a concentration

of 1 to 200 or even 1 to 500 be attained in the driving rains and dripping dews of citrus-growing countries. Field experiments with neutral Bordeaux mixture entirely agree with this. It would seem logical from these tests to expect a lime solution, at a dilution of 1 to 500, to be the cheapest and most effective spray, in orchard practice, against citrus canker.

In the absence of previous tests of the action of Bordeaux and Burgundy mixtures on bacterial plant pathogens, the foregoing tests are of interest and may be an index of the action of copper sprays against such other bacterial pathogens. It is unproved, however, since *Pseudomonas citri* may react to copper sprays differently from other bacterial plant pathogens.

SUMMARY

1. At exposures of 2½ minutes, phenol will kill *Pseudomonas citri* in a 3-day-old culture when used in a 1 to 100 solution; mercuric bichloride under the same conditions requires a 1 to 20,000 solution; *Liquor cresolis compositus* requires a 1 to 300 solution; formalin, a 1 to 20 solution.

2. Of the commercially used spray mixtures, an emulsion of *Liquor cresolis compositus* and kerosene in 2½ minutes is entirely toxic to *Pseudomonas citri* at a dilution of 1 to 50; lime sulphur, 32° Beaumé, requires a 1 to 1,000 solution; copper sulphate, a 1 to 200 solution; neutral Bordeaux mixture has no bactericidal value whatsoever; Bordeaux 4–4–50 mixture is of doubtful bactericidal value even when undiluted; Bordeaux 4–6–50 mixture at 2½ minutes' exposure is a safe bactericide even when diluted with 4 parts of water; lime when slaked is effective against *Pseudomonas citri* when diluted to a 1 to 1,000 solution.

3. Burgundy 3–3–50 mixture and Burgundy 3–4–50 mixture have little or no bactericidal value against *Pseudomonas citri* even at the longer exposures.

4. The use of formalin as a spray for the soil or the tree, or as a disinfectant, would seem to be uneconomical and in many cases entirely without value, except in a few remote instances where it might possibly be desirable partially to defoliate affected trees.

5. The definite conclusion is put forward that copper precipitate sprays as bactericides against *Pseudomonas citri* are entirely valueless unless the lime is added in excess. The toxicity of such a spray then is of more or less value in proportion to the quantity

of quicklime added in excess, and is apparently dependent upon the concentration of calcium hydroxide in the solution. A lime solution is suggested for field trial against *P. citri.*

6. The foregoing tests may possibly be an index of the action of copper sprays against bacterial plant pathogens other than *Pseudomonas citri,* although of course *P. citri* may exhibit a peculiarity in its reaction to copper sprays different from the action of other bacterial pathogens.

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NEW REARED PARASITIC HYMENOPTERA FROM THE PHILIPPINES

By A. B. Gahan

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The writer has recently had opportunity to study several series of reared parasitic wasps received by the Bureau of Entomology from the Philippine Islands. Six species have been found to be new to science and are described in the following pages. Because of the definite host records, this material is especially interesting and valuable. Two of the new species were sent in by Prof. C. F. Baker, while the others were all received from Prof. Charles S. Banks, at the time chief of the department of entomology of the College of Agriculture, at Los Baños. Two new species are said to be parasitic upon scale insects, two species were reared from the eggs of a hemipteran, one species is parasitic upon a leaf-mining buprestid, and one species issued from cocoons of a gracillarid moth.

Superfamily CHALCIDOIDEA

ENCYRTIDÆ

Homalotylus mundus sp. nov.

Very similar in appearance to *H. albitarsis* Gahan, but easily distinguished by the fact that the vertex is narrower, the legs are slightly differently colored, and the ovipositor is distinctly longer.

Female.—Length, 1.5 millimeters. Vertex, frons, and face granularly opaque; head behind the eyes faintly lineolate and more or less shining; vertex very narrow, at its narrowest point less than the length of pedicel; antennal scape long and slender; pedicel nearly three times as long as thick and distinctly longer than first funicle joint; first funicle joint approximately one and one-half times as long as thick, second slightly longer than thick; following joints subquadrate; club not thicker than the funicle and about as long as three preceding funicle joints combined, pointed at apex; pronotum and meso-

scutum scaly punctate, slightly shining; axillæ and scutellum granularly opaque; propodeum very faintly shagreened and shining; mesopleura lineolate-reticulate, subopaque; legs long, the posterior femora and tibiæ strongly compressed; middle tibial spur slender and somewhat longer than metatarsus; abdomen shorter than thorax and slightly narrower, rather strongly sculptured dorsally; ovipositor exserted about half the length of abdomen. Head, prothorax beneath, axillæ, and scutellum pale orange yellow; pronotum dorsally, mesoscutum, metathorax, propodeum, and abdomen brownish black, the propodeum and abdomen tinged with bluish; antennal scape, pedicel, and first three funicle joints blackish; funicle joints beyond the third, and the club white; tegulæ whitish basally, apical half brownish; prefectus mostly pallid; forewings subhyaline at base and apex with a broad fuscous cloud across the middle, and with a distinct narrow hairless line from the base of stigmal vein nearly to the posterior margin of wing; mesopleura, all coxæ, posterior femora above, and hind tibiæ dark brown or blackish; anterior and median femora and tibiæ, and a marginal stripe on posterior femora beneath pale testaceous; all tarsi pallid.

Male.—Agrees in every way with the description of the female.

Type locality.—LUZON, Laguna Province, Los Baños.

Type.—Catalogue No. 22344, United States National Museum.

Host.—*Pseudococcus virgatus* Cockerell.

Described from 15 specimens, 8 females and 7 males, received from Prof. C. F. Baker, by whom they were reared from the above-named coccid.

The color of this species is somewhat variable. The antennæ are not infrequently entirely white beyond the first funicle joint; legs are frequently stained with brownish, and the mesopleura vary from about the color of the mesoscutellum to nearly black.

Taftia saissetiæ sp. nov.

This species is extremely close to *T. prodeniæ* Ashmead, but is somewhat darker in color and differs also by having the funicle joints of the female antennæ distinctly compressed, those beyond the first obliquely truncate at apex and dorsally overlapping the base of the following joint; joints 3 to 6 of the funicle, viewed laterally, all distinctly broader than long and successively broader toward the club, the sixth twice as broad as long. In *prodeniæ* the funicle joints are more nearly cylindrical and all except the last are slightly longer than broad with the apical truncation squarely transverse. The males can

be distinguished from those of *prodeniæ* only by the fact that the form is slightly more robust, the propodeum mesad of the spiracle is opaque, and the face is dark green instead of strongly purplish.

Female.—Length, 1.6 millimeters. Head, pronotum, mesoscutum, axillæ, and scutellum opaquely punctate, the sculpture of scutellum very finely granular; mesopleura nearly smooth; metapleura and propodeum subopaque; abdomen as broad and about as long as the thorax, subtriangular, the dorsum weakly shagreened. General color very dark brown, the thorax above and the abdomen nearly black; propodeum and to some extent the sides of pronotum and the metapleura dark reddish testaceous; scape, pedicel, and funicle dark reddish testaceous, the funicle shading into dark brown toward apex and with the sutures between joints brown; club nearly black; legs concolorous with scape; their tibiæ somewhat darker; wings from beyond the middle of submarginal vein to apex faintly infuscated, the infuscation strongest along the submarginal vein basad of the marginal vein.

Male.—Length, 1.2 millimeters. Less-strongly sculptured than the female; viewed from in front, the head within the antennal depression weakly sculptured and more or less shining; frons and vertex opaquely punctate, with a few larger scattered punctures; antennal flagellum subcylindrical, very slightly compressed, the funicle joints subquadrate, club elongate-ovate, about as long as the two preceding funicle joints and scarcely broader than the funicle; abdomen very short, semicircular or subtriangular in outline and not much longer than the scutellum. Head, thorax, and abdomen black; scape and pedicel pale testaceous beneath, more or less brownish above; funicle and club black; coxæ concolorous with thorax; all femora and tibiæ brownish testaceous, the tarsi pale testaceous; wings subhyaline.

Type locality.—LUZON, Laguna Province, Los Baños.

Type.—Catalogue No. 22343, United States National Museum.

Host.—*Saissetia hemisphærica* Targioni.

Four females and 2 males, received from Prof. C. F. Baker, bearing his Nos. 11562 and 11563.

PTEROMALIDÆ

Acroclisoides luzonensis sp. nov.

Agrees with the characterization of the genus by Girault.[1]

Male.—Length, 1.6 millimeters. Head very broad, much

[1] Mem. Queensland Mus. 3 (1915) 334.

broader than the thorax, viewed from in front nearly one and three-fourths times as broad as long; ocellocular line nearly twice as long as the postocellar line; whole head strongly reticulate-punctate, the mouth region not striated; clypeus separated from the face by a very indistinct groove which is darker than the rest of the face; the anterior margin of clypeus triarcuately emarginate, the emarginations not deep; mandibles very large, 4-dentate; malar space at base of mandibles deeply concave; antennæ inserted above the middle of the face; scape reaching a little beyond the posterior ocelli; pedicel nearly globular; two transverse ring joints; funicle 6-jointed, the first joint approximately twice as long as the pedicel, the following funicle joints gradually decreasing in length, the sixth nearly twice longer than broad; club 3-jointed, slightly longer than the two preceding funicle joints; pronotum short, transverse, a little narrower than the mesoscutum, punctate, its posterior margin narrowly shining and impunctate; mesoscutum and scutellum sculptured like the head, the mesoscutum nearly twice as broad as long, with distinct complete parapsidal grooves; axillæ shining, with faintly reticulate sculpture; propodeum medially sculptured like the scutellum, with a very distinct median carina, the lateral folds represented by a large round fovea at base on either side of the middle, the spiracular sulci very deep, the surface of the propodeum on either side of the spiracular sulcus smooth and polished; neck of propodeum short; marginal vein of forewing distinctly though not greatly thickened; stigmal vein slightly shorter than the marginal and with a rather large knob; postmarginal very slender and somewhat longer than the marginal; abdomen approximately as long as thorax, spatulate in outline; petiole short, slender, and polished, much shorter than the hind coxæ; following tergites all smooth and polished, the second triangular and constituting about one-third the length of the abdomen; third and fourth together about equal in length to the second; those beyond the fourth very short. Head, thorax, and all coxæ bright aëneous; apex of hind coxæ more or less testaceous; abdomen brownish black with more or less bluish metallic reflections; flagellum brownish black; antennal scape, pedicel, and all of legs except their coxæ, pale reddish testaceous; wings hyaline.

Type locality.—LUZON, Laguna Province, Los Baños.

Type.—Catalogue No. 22348, United States National Museum.

Host.—*Tectocoris lineola* Fabricius.

Described from 3 males, received from Prof. Charles S. Banks, of the College of Agriculture, University of the Philippines; accession No. 18474; reared, June 24 to 27, 1918.

Professor Banks states that the parasite cuts a large sickle-shaped opening in the top of the egg when emerging, and that the larva devours less than half of the contents of the egg. There is but one parasite to the egg.

This species was reared from the same clutch of eggs as *Aphanurus banksi*, described in this paper, and may be a parasite of the *Aphanurus*.

ELASMIDÆ

Elasmus albomaculatus sp. nov.

Female.—Length, 2.3 millimeters. Antennal scape slender, pedicel shorter than the first funicle joint; funicle joints subequal, cylindrical, the first very slightly the longest, third joint approximately twice as long as thick; club about as long as joints two and three of the funicle combined; vertex and frons with large scattered punctures; pronotum and mesoscutum rather strongly scaly-punctate, each puncture with a dark hair; scutellum very faintly reticulately sculptured, nearly smooth; metanotum triangular, projecting posteriorly over the propodeum; propodeum faintly sculptured like the scutellum, without carinæ; pleura and hind coxæ laterally finely lineolate; middle femora with a single long stiff bristle on the inner side at apex; hind tibiæ posteriorly with rows of hairs arranged in distinct, diamond-shaped figures; hairs on basal joint of middle and hind tarsi in distinct rows; wings long and rather narrow, extending to apex of abdomen; abdomen somewhat longer than the head and the thorax combined. Head and mesoscutum dull blue-green; antennal flagellum brown, scape pale yellow; scutellum black, very slightly metallic; narrow line at base of tegulæ, small marginal spot on mesoscutum just above tegulæ and the triangular metanotum yellowish white, the latter with a hyaline border; propodeum dull bronze; rest of thorax, abdomen, all coxæ and all femora, except anterior pair at apex, shining black. Apices of front femora and all tibiæ whitish; tarsi mostly dark; hairs on legs black; wings hyaline.

The species is very similar to *E. elegans* Crawford, but differs in having the abdomen and all coxæ black, and in the presence of the white spot before the tegulæ. Differs from *E. philippinensis* Ashmead in having much longer funicle joints, as well as in color.

Type locality.—LUZON, Manila.

Type.—Catalogue No. 22347, United States National Museum.

Host.—*Acrocercops* sp.

Described from 2 female specimens, received from Prof. Charles S. Banks, of the College of Agriculture, University of the Philippines, accession No. 18477. Professor Banks bred the specimens from the cocoons of a moth the larva of which feeds on *Cæsalpinia pulcherrima* (L.) Sw. The moth, specimens of which were received along with the parasite, has been determined by Mr. August Busck as *Acrocercops* sp., a gracillarid.

EULOPHIDÆ

Pleurotropis anomala sp. nov.

While a typical *Pleurotropis* in every other respect, this species differs markedly from any other species known to the writer in the conformation of the mesoscutum.

Female.—Length, 1.5 millimeters. Head viewed from in front smooth and polished above the transverse groove; vertex divided by a distinct, shallow groove running from the anterior ocellus posteriorly to the occipital carinæ; between the transverse groove and base of antennæ reticulated and subopaque; below the antennæ smooth and polished; eyes with their medial margins slightly emarginate; posterior orbits very narrow; antennæ inserted near clypeus; scape slightly fusiform; pedicel pyriform, approximately one-third as long as scape and slightly shorter than the first funicle joint; funicle 3-jointed, the joints subequal and all distinctly shortly pedicellate at apex; club conic-ovate, about one and one-half times the length of third funicle joint, 2-jointed, the second joint terminating in a distinct spine; dorsal portion of pronotum polished and delicately margined anteriorly, the declivitous portion sculptured; mesoscutum with a straight, deep, transverse fold across the middle connecting the parapsidal grooves; behind this fold and extending to the posterior margin of the mesoscutum a deep, broad, rectangular depression divided by a median longitudinal ridge and homologous with the two shallow foveæ at the posterior end of the parapsidal grooves found in other species of the genus; depressed area of the mesoscutum perfectly smooth, remainder of mesoscutum and the scutellum delicately reticulate, interstices rather large and polished, those at base of scutellum longitudinally elongate and the median base of scutellum with a small area which is not reticulated; axillæ polished; propodeum polished and with delicate carinæ, the two median carinæ rather strongly diverging

posteriorly; wing veins rather slender, stigmal knob small, postmarginal very delicate and indistinct; abdomen a little longer than the head and thorax combined; first segment (petiole) about as broad as long, opaquely shagreened, and weakly margined laterally; second tergite constituting more than half the length of abdomen; above smooth and polished on basal two-thirds, the apical third delicately reticulated; beneath finely, longitudinally striated; tergites beyond the first short, subequal, very faintly sculptured. Sculptured portion of face blackish; antennæ blackish with metallic reflections; frons, vertex, pronotum dorsally, mesoscutum, scutellum, propodeum dorsally, and unsculptured portion of second abdominal segment highly metallic blue-green; thorax laterally and beneath and the legs bluish black with metallic reflections; abdomen beyond the apical third of second tergite and beneath, black; narrow apex of tibiæ and basal three joints of all tarsi whitish; two apical tarsal joints blackish; wings hyaline.

Male.—Length, 1.2 millimeters. Antennæ missing. Like the female except that the head is entirely metallic green, the sides of thorax are more strongly bluish, the abdomen is scarcely as long as thorax, its petiole distinctly longer than broad; the second tergite occupies most of the dorsal surface of abdomen and is not so distinctly striated beneath, and only the apical tarsal joint is black.

Type locality.—LUZON, Laguna Province, Los Baños.

Type.—Catalogue No. 22345, United States National Museum.

Host.—*Endelus bakeri* Kerremans.

Type, allotype, and female paratype, and the head of a third female received from Prof. Charles S. Banks, of the College of Agriculture, University of the Philippines, accession No. 18394. Reared on February 25, 1918, from the above-named leaf-mining buprestid. Antennæ from female paratype mounted on a slide.

Superfamily SERPHIDOIDEA

SCELIONIDÆ

Aphanurus banksi sp. nov.

This species runs straight to the genus *Aphanurus* in J. J. Kieffer's key to the genera of Telenominæ [2] and agrees with the description of the genus.

[2] André Spéc. Hym. Eur. Alg. 11 (1912) 7.

Female.—Length, 1.5 millimeters. Head strongly transverse, as broad as the thorax, strongly rugose-punctate; ocelli touching the eye margin; front of head between base of antennæ and anterior ocellus with strong, transversely directed rugæ, except a small, nearly smooth area immediately in front of the ocellus; malar space with two strong, parallel carinæ running from the clypeus to the eye margin, and a third, weaker, subparallel carina behind these two; the middle carina continued as a sharp orbital carina narrowly separated from the eye margin and reaching to the vertex; eyes glabrous; antennal scape reaching to the front ocellus; pedicel slender, about twice as long as broad at apex; third antennal joint a little longer than the pedicel, fourth a little longer than broad and narrower at base than at apex; fifth transverse; club distinctly 6-jointed, the joints all slightly broader than long, except the last, which is a little longer than broad; thorax coarsely sculptured; mesoscutum posteriorly with coarse, irregular, longitudinal striation; scutellum coarsely rugose; propodeum very short, visible from above only laterally where it is rugosely sculptured, more or less concave behind, the concave posterior face bounded by a sharp carina; stigmal vein of front wing more than twice as long as the marginal, postmarginal nearly twice as long as the stigmal; abdomen about as long as thorax; first tergite strongly longitudinally striate, second tergite coarsely foveolate at base and with the basal three-fourths indistinctly striate, apical fourth of the second tergite and all of the short third tergite smooth, tergites beyond third concealed from above; second sternite extending nearly to apex of abdomen, coarsely foveolate at base, strongly longitudinally striate anteriorly and laterally, with the posterior middle area and the apex smooth and polished. Black; scape, pedicel, three basal joints of the flagellum and legs, except coxæ, reddish testaceous; wings hyaline.

Male.—Agrees with the female except that the antennæ are reddish testaceous, only the club slightly brownish; pedicel is scarcely longer than broad; the third antennal joint is approximately twice as long as pedicel, the fourth very slightly shorter than third, the fifth about one and one-half times as long as broad, the sixth very slightly longer than broad, the seventh to the tenth globular and shortly petiolate, the eleventh conical and one and one-half times as long as broad. The anterior

carina as well as the posterior one on the malar space are weaker than in the female, only the median one being prominent.

Type locality.—LUZON, Laguna Province, Los Baños.

Type.—Catalogue No. 22346, United States National Museum.

Host.—*Tectocoris lineola* Fabricius.

Two females, 3 males, and 1 broken specimen, the sex of which cannot be determined, received from Prof. Charles S. Banks, under College of Agriculture, University of the Philippines, accession No. 18476; reared, July 5 to 23, 1918, from the eggs of *Tectocoris lineola* Fabricius.

THE PSYLLIDÆ OF BORNEO

By D. L. Crawford

Of the College of Hawaii

ONE PLATE

Our knowledge of the psyllid fauna of Borneo is fragmentary and far from complete, as only a few localities on this large island have been visited by collectors. The most extensive collections in the group have been made by Prof. C. F. Baker. Several interesting forms have been captured there by Mr. Frederick Muir also.

There is presented here a list of all the Bornean Psyllidæ known to me, together with descriptions of several new species.

PAUROPSYLLINÆ

Pauropsylla udei Rübsaamen.

A species very widely distributed throughout the East Indies and tropical Asia. Two specimens collected at Sandakan, Borneo (*C. F. Baker*).

Paurocephala psylloptera Crawford.

A single female specimen taken at Sandakan, Borneo (*Baker*), probably belongs to this species, although it is a little smaller than the average Philippine specimen and has somewhat darker forewings. This is a widely distributed species in tropical Asia and Oceania and is, therefore, subject to some variation. *Agonoscena sauteri* Enderlein is a synonym of this.

Macrohomotoma apsylloides (Crawford).

Pauropsylla apsylloides Crawford.

This species was at first referred to the genus *Pauropsylla* with some hesitation, but subsequent comparisons indicate its very close relationship to *Macrohomotoma gladiatum* Kuwayama, a Formosan species. In wing venation and cephalic characters it is very similar to Kuwayama's species, but differs a little in the female genitalia, in the Formosan species the genital segment being comparatively shorter.

A male specimen was taken at Sandakan, Borneo (*Baker*). The following description of the male genitalia supplements the

previous description of the species which lacked this: Forceps slender, moderately long, slightly clavate distad, not as long as height of anal valve; anal valve large, with a caudal projection about as long as height of anal valve.

The East African species of this genus (*M. nyasae* Newstead)[1] is remarkably similar in male and female genital characters but differs in minor wing venational features.

This genus appears certainly to be related to the Pauropsyllinæ instead of to the Carsidarinæ.

Genus **TRIGONON** novum

Head much deflexed, short, without genal processes; vertex triangular, converging in front to a narrow point at front ocellus; genæ extending laterad somewhat beyond vertex. Antennæ very long and slender, as long as body to tip of folded wings or longer. Eyes very large, hemispherical. Thorax strongly arched, hirsute. Forewings more or less transparent, rounded at apex, veins setiferous; pterostigma present.

Type of the genus, *Heteropsylla longicornis* Crawford.

The most distinctive features of this genus are the triangular vertex and excessively long antennæ. Two species are included, both from the South Pacific.

Trigonon pacificum sp. nov. Plate 1, fig. 6.

Related to *T. longicornis* Crawf., a South Pacific species, but much larger.

Length of body (female), 4.4 millimeters; length from head to tip of folded wing, 5.7. General color brown, with a pale stripe down center of thoracic dorsum and two black stripes on each side of mid line.

Head short, broad, sparsely hirsute; vertex strongly concave, posterior ocelli elevated; frons visible around front ocellus and beneath it to labrum; genæ large, nearly meeting over frons at one point just beneath front ocellus, not produced into conical processes or lobes, except for a very small tubercle on each gena opposite the labrum. Antennæ very long and slender, as long as body to tip of folded wings.

Thorax rather broad, stout, sparsely hirsute. Legs short; hind tibiæ stout, with a small spur at base and several spines at apex. Forewing fumate or slightly browned but transparent, narrowly rounded at apex, veins with short setæ, costa thick

[1] Ent. News 25 (1914) 62–65.

and densely hairy; each apical cell of wing brownish near apical margin, with a clear spot in each at margin.

Female genital segment very long and acuminate, longer than rest of abdomen, acute at apex.

BORNEO, Sandakan (*Baker*), 1 female.

Diclidophlebia[2] **oceanica** Crawford.

This very remarkable and apparently rare species was described from two specimens from the Philippines and one from Singapore. One specimen has been taken by C. F. Baker at Sandakan, Borneo, which is similar in all important respects and probably represents the same species. The Borneo specimen is a little larger, and the legs are somewhat more foliaceous. Wing venation differs only in minor characteristics. There are scarcely enough differences to warrant making a new species for the Borneo form.

Tenaphalara juliana Crawford.

An additional specimen (female) has been received from C. F. Baker. The female genital segment is moderately short, and stout at base; the apical one-third is abruptly narrowed and small, black in contrast to the orange color of the basal portion, acutely pointed.

The forelegs have a narrow black or brown stripe on inner side. Closely related to *T. malayensis*, but quite distinct from that species.

Tyora ornata (Kirkaldy).

Nesiope ornata KIRKALDY.

Walker's old genus *Tyora* has been misunderstood by subsequent students of this family, except by Scott who figured the species from Walker's type. *Tyora congrua*, Walker's type species, is not at all congeneric with certain Australian species referred to that genus, but appears to be identical with a South Pacific species described recently as *Carsidaroida heterocephala* Crawford and subsequently referred by me to Kirkaldy's genus *Nesiope*. In other words, *Nesiope* Kirkaldy, and hence *Carsidaroida* Crawford, become synonyms of *Tyora* Walker.

Tyora (*Nesiope*) *ornata* was first discovered in Fiji, but probably exists in other parts of the South Pacific, since it is now recorded from Borneo. One male was taken at Sandakan

[2] Diclidophlebia nom. nov. pro *Heteroneura* Crawford. The latter name is preoccupied in Diptera.

(*Baker*) which appears almost certainly to be identical with Kirkaldy's *Nesiope ornata,* of Fiji.

Tyora hibisci Froggatt and *T. indica* Crawford should be referred to *Mesohomotoma,* a genus erected in 1907 by Kuwayama for a species undoubtedly congeneric with the two mentioned above. *Udamostigma* was proposed by Enderlein in 1910 for Froggatt's *T. hibisci,* but *Mesohomotoma* has the right of priority.

Genus TRIOZA Foerster

The genus *Trioza* is not abundantly represented in the Old World Tropics. The members of this genus have the hind tibiæ unspurred and the basal tarsus of the hind legs without apical clawlike spines; in the forewings the basal vein forks at one point into three veins. *Megatrioza* is a common genus in the Palæotropics, differing from *Trioza* chiefly in the armature of the hind tibiæ. It is a curious fact that several other palæotropical genera of Triozinæ have the hind tibiæ more or less armed as in *Megatrioza.*

Two closely allied but distinct species in Borneo have certain *Trioza* characters, but still are not typical members of that genus. Provisionally, however, they may be grouped in *Trioza.*

Trioza insula sp. nov. Plate 1, fig. 2.

Length of body, 2.3 millimeters (female); forewing, 3. General color light brown, eyes and part of vertex adjoining eyes black, a black spot on mesopleura. Head short in dorsal aspect, vertex smooth, without depressions, rounded foreward and down, in front extending down narrowly on each side and beyond front ocellus between bases of genal cones. Genal cones half as long as vertex, conical, subacute, divergent. Antennæ about twice as long as width of head, moderately stout.

Thorax smooth, surface reticulately marked. Hind tibiæ with a very small spur at base and three spines at apex. Forewing long and narrow, acutely pointed, hyaline, with a brown stripe along posterior margin from claval suture to apex; media and cubitus not forking from basal trunk at same point with radius; radius short. Hind wing a little more than half as long as forewing.

Female genital segment nearly as long as rest of abdomen, subacute at apex.

BORNEO, Sandakan (*Baker*), 1 female.

Trioza papillata sp. nov. Plate 1, fig. 3.

Very obviously related to *T. insula* but quite different in several respects. Insect much smaller, body, about 1 millimeter long; forewing, 2 millimeters long. Vertex as in related form, extending forward in front of front cellus; genal cones small, fingerlike or nipplelike in shape, separate at base and slender, acute. Antennæ black, twice as long as width of head. Legs small and slender. Forewings similar to *T. insula* in shape and venation, but smaller and without brown band. Female genital segment about as long as rest of abdomen, acute at apex.

BORNEO, Sandakan (*Baker*), 1 female.

Megatrioza asiatica Crawford.

This tropical Asiatic species appears to be present in Borneo, being represented in C. F. Baker's collection by four specimens which closely resemble specimens from other regions. These were taken at Sandakan, Borneo.

Megatrioza eugenioides Crawford.

This species appears to be rather widely distributed in tropical Asiatic regions. Several additional specimens have been taken by Baker at Sandakan, Borneo.

Megatrioza grandis sp. nov. Plate 1, fig. 1.

Somewhat similar to *M. gigantea* Crawford, but longer and slenderer. Length from head to tip of folded wings, 8 millimeters or more. Orange to light brown, few or no markings on body; legs and antennæ concolorous, wings slightly fuscous.

Genal cones shorter than vertex, broad and rounded, sparsely hairy. Antennæ nearly twice as long as width of head, slender. Thorax long. Legs long, rather stout; hind tibiæ with large spur at base and three short spines at apex. Forewing very long, three times as long as broad, subacute at apex; upper fork of media terminating at wing tip; cubitus forked distad of mid-point. Hind wings about half as long as forewings.

Male forceps nearly as long as anal valve, slender, curved, with a fringe of hairs on posterior margin; anal valve broad, posterior margin bulging caudad, with a fringe of long hairs.

BORNEO, Sandakan (*Baker*), 1 male.

Leuronota attenuata sp. nov. Plate 1, fig. 4.

Length of body, 2.2 millimeters; forewings, 4.0; length from head to tip of folded wings, 4.8. General color light brown with black irregular markings on thorax; forewings light brown, not transparent, thickly mottled with small black or brown spots.

Body narrow, long, dorsum not at all arched. Head porrect, vertex as long as broad, protruding forward in two short, blunt epiphyses; genal cones nearly as long as vertex, porrect, constricted at base, diverging, acute, hairy. Antennæ twice as long as width of head, slender.

Thorax with a sparse clothing of long hairs; tibiæ more densely hirsute; hind tibiæ with a spur at base and one long and three shorter spines at apex. Forewing opaque, long and narrow, acutely pointed at apex, strikingly mottled, veins setose. Hind wings nearly as long as forewings.

Male genitalia: Forceps about as long as anal valve, broad at apex, moderately stout; anal valve short, apex truncate, each side protruding a little caudad at apex.

BORNEO, Sandakan (*Baker*), 1 male.

Leuronota microceras (Crawford).

This was described as a *Cerotrioza* from one specimen taken in West Borneo (Mowong) by F. Muir. It is specifically quite distinct from the new species described above, but should be referred to the genus *Leuronota* instead of *Cerotrioza*.

Arytaina pulchra sp. nov. Plate 1, fig. 5.

Length of body, 2 millimeters; forewings, 2.5 millimeters. General color brownish; vertex, pronotum, and mesonotum light brown, the rest dark brown with irregular light markings and spots; forewings strikingly maculated with dark brown.

Head not strongly deflexed; vertex a little more than half as long as wide; genal cones nearly as long as vertex, divergent, porrect, subacute. Antennæ very long and slender, about as long as body to tip of forewings.

Thorax briefly pubescent. Legs slender, femora spotted with brown. Forewings broadest subapically, rather square at apex and narrowing toward base, transparent except on maculæ, veins spotted. Hind wings nearly as long as forewings. In shape of forewings this seems to resemble species of *Diaphorina*, but is distinct in other characters.

Female genital segment short, both valves acutely pointed.
BORNEO, Sandakan (*Baker*), 1 female.

Arytaina variabilis Crawford.

Probably this is a widely distributed species, as it has been found in the Philipines, Malay Peninsula, and now in Borneo, all by C. F. Baker. The dark band on the hind margin of the forewing makes this an easily recognized species.

Psylla fumosa Crawford.

Six more specimens of this species have been collected by Baker at Sandakan, Borneo, all closely resembling the type, and bearing the same similarity to the Philippine species, *P. crenata.*

ILLUSTRATION

Plate 1

Forewings of Psyllidæ. (Stippled areas represent solid coloration of wing membrane.)

Fig. 1. *Megatrioza grandis* sp. nov.; original drawing, about × 25.
2. *Trioza insula* sp. nov.; original drawing, × 35.
3. *Trioza papillata* sp. nov.; original drawing, × 28.
4. *Leuronota attenuata* sp. nov.; original drawing, × 24.
5. *Arytaina pulchra* sp. nov.; original drawing, × 28.
6. *Trigonon pacificum* g. et sp. nov.; original drawing, × 28.

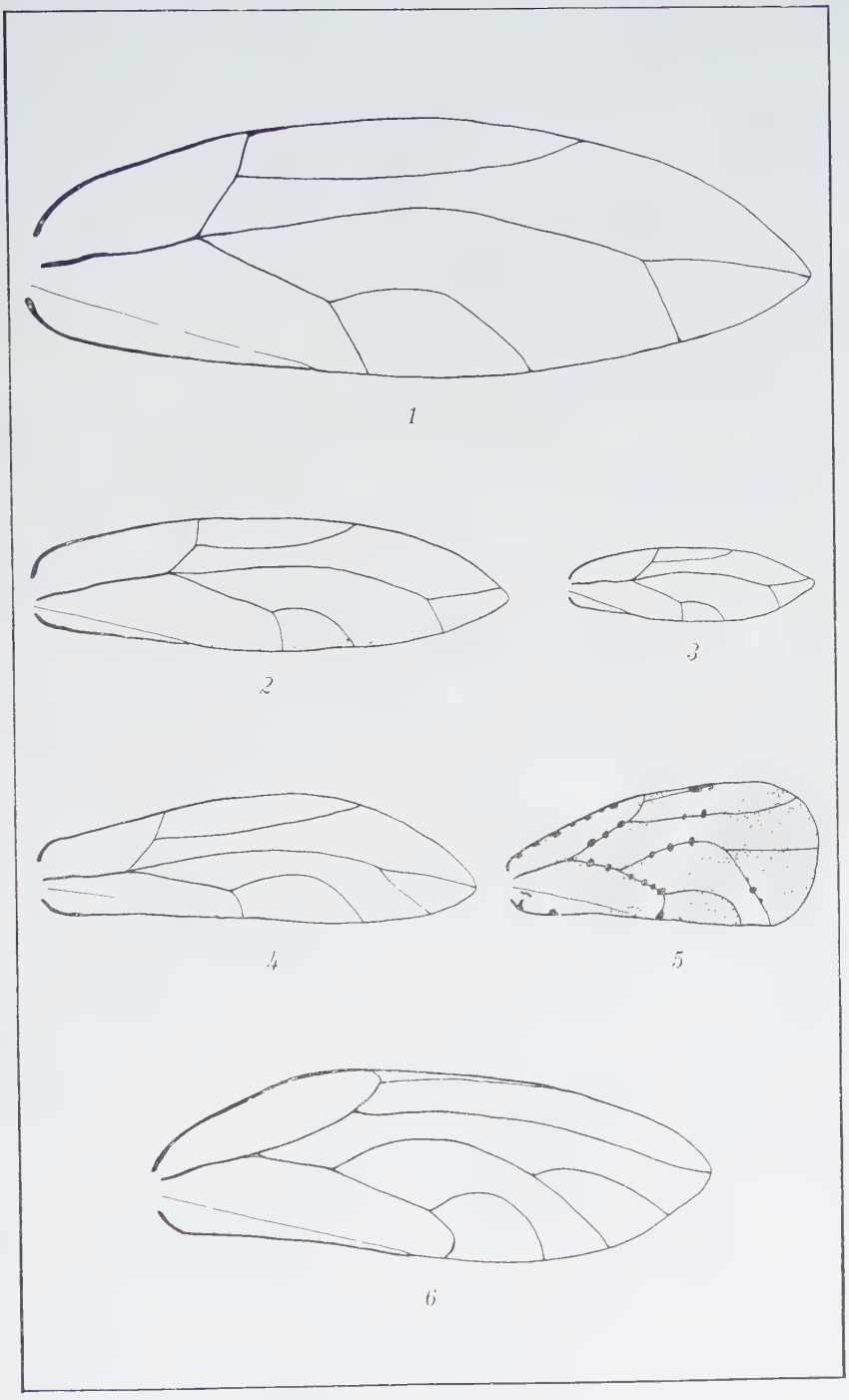

PLATE 1. FOREWINGS OF PSYLLIDÆ.

HIGHER BASIDIOMYCETES FROM THE PHILIPPINES AND THEIR HOSTS, IV

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The following list is a continuation of determinations of Philippine higher Basidiomycetes and wood-destroying fungi collected primarily on Mount Maquiling or in the vicinity of Los Baños, Laguna Province, Luzon. The collections have been made either by me or by my students under my direction. All identifications as herein given were made by N. Patouillard, of Neuilly-sur-Seine, France.

The species are grouped, in so far as possible, according to the classification of Engler and Prantl, with the host and the collector under each species of fungus. The numbers refer to the College of Agriculture fungus herbarium.

AURICULARIACEAE

AURICULARIA Bulliard

AURICULARIA MESENTERICA (Dicks.) Fr.

Annonaceae, Mount Maquiling, *Reinking 142*, on dead branches.

Bassia betis (Blanco) Merr., Mount Maquiling, *Cazeñas 1050*, on dead branches.

AURICULARIA POLYTRICHA (Mont.) Sacc.

Annona muricata Linn., Los Baños, *Reinking 3032*, on dead branches.

Bixa orellana Linn., Mount Maquiling, *Reinking 3121*, on dead branches.

Canarium villosum (Miq.) F.-Vill., Mount Maquiling, *Reinking 3097*, on dead branches.

Cleidion javanicum Blume, Mount Maquiling, *Reinking 3064, 3092*, on dead branches.

Ficus angustissima Merr., Mount Maquiling, Laguna, *Reinking 6463*, on dead branches.

Koordersiodendron pinnatum (Blanco) Merr., Mount Maquiling, *Reinking 3287*, on dead branches.

Lagerstroemia speciosa (Linn.) Pers., Mount Maquiling, *Reinking 4611,* on dead branches.

Manihot utilissima Pohl, Los Baños, *Morada 3201,* on dead stem.

Solanum grandiflorum Ruiz et Pav., Los Baños, *Reinking 3292,* on dead stems.

Streblus asper Lour., Mount Maquiling, *Reinking 3027,* on dead branches.

AURICULARIA TENUIS Lév.

Euphorbia hypericifolia Linn., Mount Maquiling, *Reinking 1080,* on dead bark.

Pterospermum obliquum Blanco, Mount Maquiling, *Reinking 3128,* on dead branches.

AURICULARIA VELUTINA (Lév.) Pat.

Ficus benjamina Linn., Mount Maquiling, *Pañganiban 1010,* on dead branches.

TREMELLACEAE

HETEROCHAETE Patouillard

HETEROCHAETE GELATINOSA (Berk.) Pat.

Koordersiodendron pinnatum (Blanco) Merr., Mount Maquiling, Laguna, *Reinking 6469,* on dead branches.

DUPORTELLA Patouillard

DUPORTELLA TRISTIUSCULA (Berk.) Pat. (*D. velutina* Pat. = *Corticium tristiusculum* Berk. = *Hymenochaete tristiusculum* Massee.)

Acacia farnesiana (Linn.) Willd., Mount Maquiling, *Reinking 3985,* on dead branches.

Albizzia procera (Roxb.) Benth., Mount Maquiling, *Reinking 4420,* on dead twigs.

Barringtonia racemosa (Linn.) Blume, Mount Maquiling, *Reinking 4288,* on dead branches.

Bauhinia, Mount Maquiling, *Reinking 4051,* on dead branches.

Caesalpinia sappan Linn., Mount Maquiling, *Reinking 4227,* on dead twigs.

Celtis philippensis Blanco, Mount Maquiling, *Reinking 4228,* on dead twigs.

Citrus maxima (Burm.) Merr. (*Citrus decumana* Linn.), College Ground, Los Baños, *Reinking 4020,* on dead twigs.

Clerodendron minahassae Teysm. & Binn., Mount Maquiling, *Reinking 2687,* on dead wood.

Eriobotrya japonica Lindl., Mount Maquiling, *Reinking 4081,* on dead wood.

Eugenia jambolana Lam., Mount Maquiling, Reinking *4449*, on dead branches.

Evodia, Mount Maquiling, *Reinking 4439*, on dead twigs.

Ficus nota (Blanco) Merr., Mount Maquiling, *Reinking 3970*, on dead branches.

Grevillea robusta A. Cunn., Mount Maquiling, *Reinking 3927*, on dead branches.

Lagerstroemia speciosa (Linn.) Pers., Mount Maquiling, *Reinking 4255*, on dead branches.

Macaranga tanarius (Linn.) Muell.-Arg., Mount Maquiling, *Reinking 3999*, on dead branches.

Mangifera indica Linn., College Ground, Los Baños, *Reinking 3996*, on dead branches.

Parashorea plicata Brandis, Mount Maquiling, *Reinking 3952*, on dead branches.

Parinarium griffithianum Benth., Mount Maquiling, *Reinking 4058*, on dead branches.

Premna sp., Mount Maquiling, *Reinking 3917*, on dead branches.

Pterocarpus indicus Willd., Mount Maquiling, *Reinking 4418*, on dead twigs.

Quercus bennettii Miq., Mount Maquiling, *Reinking 4096*, on dead wood.

Semecarpus cuneiformis Blanco, Mount Maquiling, *Reinking 3925*, on dead branches.

Tamarindus indica Linn., Mount Maquiling, *Reinking 4060*, on dead branches.

TREMELLA Dillenius

TREMELLA FUCIFORMIS Berk.

Mount Maquiling, *Marquez 871*, on dead branches.

DACRYOMYCETACEAE

GUEPINIOPSIS Patouillard

GUEPINIOPSIS SPATHULARIUS (Schw.) Pat.

Bambusa vulgaris Schrad., Mount Maquiling, *Sobrepeña 789*, on living culm.

THELEPHORACEAE

STEREUM Persoon

STEREUM BORYANUM Fr.

Ficus benjamina Linn., College Ground, Los Baños, *Marquez 971*, on dead branches.

Ficus religiosa Linn., Forestry Nursery, Los Baños, *Pañganiban 741*, on dead wood.

STEREUM LOBATUM Fr.

Mount Maquiling, *Mendoza 2510*, on dead wood.

STEREUM MELLISII Berk.

Bambusa, Sulu, Jolo, *Reinking 2432*, on dead culms.

STEREUM PERLATUM Berk.

Mangifera indica Linn., College Ground, Los Baños, *Collado 1800*, on dead branches.

STEREUM SPECTABILE Mont.

Mount Maquiling, *Reyes 1203*, on decaying wood.

STEREUM SURINAMENSE Lév.

Mount Maquiling, *Cazeñas 3418*, on dead wood.

CLADODERRIS Persoon

CLADODERRIS CAPERATA Mont. var. **SPONGIGES** (Berk.) Cooke.

Psidium guajava Linn., College Ground, Los Baños, *Lontok 998*, on dead leaves.

CLADODERRIS DENDRITICA Pers.

Calamus, Mount Maquiling, *Collado 1849*, on dead stem.

PHAEOCYPHELLA Patouillard

PHAEOCYPHELLA HIBISCI Pat.

Morinda bracteata Roxb., Mount Maquiling, *Reinking 3091*, on dead branches.

CLAVARIACEAE

PTERULA Fries

PTERULA CAPILLARIS Lév.

Schizostachyum, Mount Maquiling, *Reinking 2633*, on dead culms.

PTERULA FASCICULARIS Bres. et Pat.

Annona reticulata Linn., College Ground, Los Baños, *Reinking 3689*, on dead branches.

PTERULA SIMPLEX Sacc. et Paol.

Bambusa, College Ground, *Limbo 5585*, on dead culms.

Bambusa spinosa Roxb. (*B. blumeana* Schultes), College Ground, Los Baños, *Reyes 383*, on dead culms.

LACHNOCLADIUM Léveillé

LACHNOCLADIUM BRASILIENSE Berk. (*L. samoense* P. Henn.)

Mount Maquiling, *Reyes 230*, on soil.

LACHNOCLADIUM PUNGENS Lév. (sub *Merisina*).[1]

Mount Maquiling, *Collado 1349*, on dead wood.

POLYPORACEAE

PORIA Persoon

PORIA (POROGRAMME) FULIGO Berk.

Bambusa spinosa Roxb. (*B. blumeana* Schultes), Mount Maquiling, Laguna, *Zschokke 5967*, on dead culms.

PORIA (POROGRAMME) RAVENALAE Berk.

Livistona rotundifolia Mart., Los Baños, Laguna, *Serrano 6571*, on dead leaf petioles.

GANODERMA Karstner

GANODERMA LEUCOPHAEUM (Mont.) Pat.

Mount Maquiling, *Baybay 3376*, on dead branches.

GANODERMA RUGOSUM Nees.

Mount Maquiling, *Santos 413*, on soil.

POLYPORUS Micheli

POLYPORUS AFFINIS Nees.

Mount Maquiling, *Cazeñas 3432*, on dead branches.

POLYPORUS ARCULARIUS Fr.

Mount Maquiling, *Marquez 1086*, on dead wood.

POLYPORUS BICOLOR Jungh.

Ficus benjamina Linn., Mount Maquiling, *Pañganiban 966*, on dead wood.

POLYPORUS CARYOPHYLLI Racib.

Citrus, Los Baños, *Pañganiban 211*, on dead wood.

POLYPORUS COHERENS Lév.

Mount Maquiling, *Nantes 2517*, on dead wood.

POLYPORUS CONTRACTUS Berk.

Mount Maquiling, *Pañganiban 3334*, on dead branches.

POLYPORUS GRAMMOCEPHALUS Berk.

Mount Maquiling, *Marquez 978*, on dead branches.

[1] Patouillard notes that this is a species which does not seem to have been refound since its collection at Java by Zollruger. It has nothing in common with the one which Hennings named *Pterula pungens*.

POLYPORUS HIRSUTUS Fr.

Citrus nobilis Lour., Los Baños, *Lindayag 1257,* on dead wood.

POLYPORUS INAMCENUS Mont.

Mount Maquiling, *Nantes 660,* on dead wood.

POLYPORUS LICNOIDES Mont.

Lansium domesticum Correa, Los Baños, *Hernandez 1211,* on dead wood.

POLYPORUS MELAENUS Lév.

Mount Maquiling, *Nantes 2485,* on dead wood.

POLYPORUS PACHYPHLOEUS Pat.

Parashorea plicata Brandis, Mount Maquiling, *Collado 1397,* on dead wood.

POLYPORUS PINSITUS Fr.

Leucaena glauca Benth., Mount Maquiling, *Jimenez 3190,* on dead wood.

POLYPORUS RIGIDUS Lév.

Mount Maquiling, *Nantes 679,* on dead wood.

POLYPORUS RUGULOSUS Lév.

Bambusa, Sulu, Jolo, *Reinking 2433,* on dead culms.

Bambusa vulgaris Schrad., Mount Maquiling, *Reyes 320,* on dead culms.

Strychnos nux-vomica Linn., Mount Maquiling, Laguna, *Reinking 6448,* on dead branches.

POLYPORUS VELLEREUS Berk.

Gliricidia sepium (Jacq.) Steud., Mount Maquiling, *Reyes 269,* on dead wood.

POLYPORUS XANTHOPUS Fr.

Mount Maquiling, *Reinking 3449,* on dead branches.

TRAMETES Fries

TRAMETES DERMATODES Lév.

Clerodendron minahassae Teysm. & Binn., Mount Maquiling, *Reinking 4275,* on dead branches.

TRAMETES MEYENII Kl.

Pithecolobium dulce (Roxb.) Benth., Mount Maquiling, *Divinagracia 1054,* on decaying wood.

TRAMETES OCCIDENTALIS Fr.

Mount Maquiling, *Reinking 3171,* on dead wood.

TRAMETES PERSOONII Mont.

Manihot utilissima Pohl, Los Baños, *Morada 3204,* on dead stem.

TRAMETES TEGULARIS Lév.

Mount Maquiling, *Nantes 912,* on dead wood.

LENZITES Fries

LENZITES PALISOTI Fr.

Bambusa spinosa Roxb. (*Bambusa blumeana* Schultes), Mount Maquiling, *Villanueva 972,* on dead culms.

Clerodendron minahassae Teysm. & Binn., Mount Maquiling, *Reinking 2697,* on dead wood.

Macaranga tanarius (Linn.) Muell.-Arg., Mount Maquiling, *Marajas 913,* on dead bark.

HEXAGONA Fries

HEXAGONA THWAITESII Berk. var. **RETROPICTA** Bres.

Cordia myxa Linn., Mount Maquiling, *Pañganiban 1013,* on dead wood.

Gliricidia sepium (Jacq.) Steud., Mount Maquiling, *Villanueva 220,* on dead branches.

LASCHIA Montagne

LASCHIA CUTICULARIS Lév.

Bambusa, College farm, Los Baños, *Collado 58,* on dead culms.

POROLASCHIA Patouillard

POROLASCHIA TONQUINENSIS Pat.

Bambusa vulgaris Schrad., var. *striata* (Lodd.) Gamble, College farm, Los Baños, *Reyes 309,* on dead culms.

FAVOLUS Fries

FAVOLUS MULTIPLEX Lév. (*Favolus spathulatus* Jungh.)

Ficus, Mount Maquiling, *Collado 1461,* on dead wood.

FAVOLUS PHILIPPINENSIS Berk. var. **OBSCURATA** Bres.

Mount Maquiling, *Reyes 3318,* on dead wood.

LEUCOPORUS Patouillard

LEUCOPORUS ARCULARIUS (Fr.) Pat.

Mount Maquiling, Laguna, *Collado 1369,* on dead branches.

LEUCOPORUS GALLOPAVONIS (Berk.) Pat.

Cocos nucifera Linn., Los Baños, *Alas 3178,* on dead trunk.

AGARICACEAE

TROGIA Fries

TROGIA PARTITA (Berk.) Pat.

Mount Maquiling, *Cazeñas 3399,* on dead wood.

SCHIZOPHYLLUM Fries

SCHIZOPHYLLUM COMMUNE Fr.

Blumea balsamifera (Linn.) DC., Mount Maquiling, *Reinking 2831,* on dead wood.

Hevea brasiliensis (HBK.) Muell.-Arg., Mindanao, *Reinking 2782,* on dead roots.

Kigelia pinnata DC., Mount Maquiling, *Reinking 3320,* on dead branches.

Mallotus ricinoides (Pers.) Muell.-Arg., Mount Maquiling, *Reinking 3106,* on dead branches.

Manihot utilissima Pohl, Los Baños, *Morada 3196,* on dead stem.

Persea gratissima Gaertn., Mount Maquiling, *Reinking 2811,* on dead wood.

Tamarindus indica Linn., College Ground, Los Baños, *Reinking 2855,* on dead wood.

XEROTUS Fries

XEROTUS NIGRITA Lév.

Los Baños, *Divinagracia 3439,* on dead branches.

LENTINUS Fries

LENTINUS BRACCATUS Lév.

Oryza sativa Linn., Los Baños, *Ocfemia 3898,* on dead sterile panicles.

LENTINUS VILLOSUS Kl.

Mount Maquiling, *Reinking 3169,* on dead wood.

CRINIPELLIS Patouillard

CRINIPELLIS GALEATUS (B. et C.) Pat.

Prosopis vidaliana Naves, Mount Maquiling, *Reinking 3122,* on dead branches.

CRINIPELLIS STIPITARIA Pers.

Litsea perrottetii F.-Vill., Mount Maquiling, *Catalan 4464,* on dead twigs.

CLATHRACEAE

SIMBLUM Klotzsch

SIMBLUM GRACILE Berk. (*S. periphragmoides* Kl. = *S. flavescens* Berk.)

Bambusa, Los Baños, *Ocfemia 4149,* on post.

LYCOPERDACEAE

CALVATIA

CALVATIA LILACINA (Mont.) Pat.

Mount Maquiling, *Reinking 3275,* on dead branches.

FUNGI LISTED ACCORDING TO HOSTS

ACACIA FARNESIANA (Linn.) Willd.
Duportella tristiuscula (Berk.) Pat., dead branches.

ALBIZZIA PROCERA (Roxb.) Benth.
Duportella tristiuscula (Berk.) Pat., dead twigs.

ANNONACEAE.
Auricularia mesenterica (Dicks.) Fr., dead branches.

ANNONA MURICATA Linn.
Auricularia polytricha (Mont.) Sacc., dead branches.

ANNONA RETICULATA Linn.
Pterula fascicularis Bres. et Pat., dead branches.

BAMBUSA.
Laschia cuticularis Lév., dead culms.
Polyporus rugulosus Lév., dead culms.
Pterula simplex Sacc. et Paol., dead culms.
Simblum gracile Berk., on post.
Stereum mellisii Berk., dead culms.

BAMBUSA SPINOSA Roxb. (*Bambusa blumeana* Schultes.)
Lenzites palisoti Fr., dead culms.
Poria (*Porogramme*) *fuligo* Berk., dead culms.
Pterula simplex Sacc. et Paol., dead culms.

BAMBUSA VULGARIS Schrad.
Guepiniopsis spathularius (Schw.) Pat., living culm.
Polyporus rugulosus Lév., dead culms.

BAMBUSA VULGARIS Schrad. var. STRIATA (Lodd.) Gamble.
Porolaschia tonquinensis Pat., dead culms.

BARRINGTONIA RACEMOSA (Linn.) Blume.
Duportella tristiuscula (Berk.) Pat., dead branches.

BASSIA BETIS (Blanco) Merr.
Auricularia mesenterica (Dicks.) Fr., dead branches.

BAUHINIA.
Duportella tristiuscula (Berk.) Pat., dead branches.

BIXA ORELLANA Linn.
Auricularia polytricha (Mont.) Sacc., dead branches.

BLUMEA BALSAMIFERA (Linn.) DC.
Schizophyllum commune Fr., dead wood.

CAESALPINIA SAPPAN Linn.
Duportella tristiuscula (Berk.) Pat., dead twigs.

CALAMUS.
Cladoderris dendritica Pers., dead stem.

CANARIUM VILLOSUM (Miq.) F.-Vill.
Auricularia polytricha (Mont.) Sacc., dead branches.

CELTIS PHILIPPENSIS Blanco.
Duportella tristiuscula (Berk.) Pat., dead twigs.

CITRUS.
Polyporus caryophylli Racib., dead wood.

CITRUS MAXIMA (Burm.) Merr. (*Citrus decumana* Linn.)
Duportella tristiuscula (Berk.) Pat., dead twigs.

CITRUS NOBILIS Lour.
Polyporus hirsutus Fr., dead wood.

CLEIDION JAVANICUM Blume.
Auricularia polytricha (Mont.) Sacc., dead branches.

CLERODENDRON MINAHASSAE Teysm. & Binn.
Duportella tristiuscula (Berk.) Pat., dead wood.
Lenzites palisoti Fr., dead wood.
Trametes dermatodes Lév., dead branches.

COCOS NUCIFERA Linn.
Leucoporus gallopavonis (Berk.) Pat., dead trunk.

CORDIA MYXA Linn.
Hexagona thwaitesii Berk. var. *retropicta* Bres., dead wood.

ERIOBOTRYA JAPONICA Lindl.
Duportella tristiuscula (Berk.) Pat., dead wood.

EUGENIA JAMBOLANA Lam.
Duportella tristiuscula (Berk.) Pat., dead branches.

EUPHORBIA HYPERICIFOLIA Linn.
Auricularia tenuis Lév., dead bark.

EVODIA.
Duportella tristiuscula (Berk.) Pat., dead twigs.

FICUS.
Favolus multiplex Lév., dead wood.

FICUS ANGUSTISSIMA Merr.
Auricularia polytricha (Mont.) Sacc., dead branches.

FICUS BENJAMINA Linn.
Auricularia velutina (Lév.) Pat., dead branches.
Polyporus bicolor Jungh., dead wood.
Stereum boryanum Fr., dead branches.

FICUS NOTA (Blanco) Merr.
Duportella tristiuscula (Berk.) Pat., dead branches.

FICUS RELIGIOSA Linn.
Stereum boryanum Fr., dead wood.

GLIRICIDIA SEPIUM (Jacq.) Steud.
Hexagona thwaitesii Berk. var. *retropicta* Bres., dead branches.
Polyporus vellereus Berk., dead wood.

GREVILLEA ROBUSTA A. Cunn.
Duportella tristiuscula (Berk.) Pat., dead branches.

HEVEA BRASILIENSIS (HBK.) Muell.-Arg.
Schizophyllum commune Fr., dead roots.

KIGELIA PINNATA DC.
Schizophyllum commune Fr., dead branches.

KOORDERSIODENDRON PINNATUM (Blanco) Merr.
Auricularia polytricha (Mont.) Sacc., dead branches.
Heterochaete gelatinosa (Berk.) Pat., dead branches.

LAGERSTROEMIA SPECIOSA (Linn.) Pers.
Auricularia polytricha (Mont.) Sacc., dead branches.
Duportella tristiuscula (Berk.) Pat., dead branches.

LANSIUM DOMESTICUM Correa.
Polyporus licnoides Mont., dead wood.

LEUCAENA GLAUCA Benth.
Polyporus pinsitus Fr., dead wood.

LITSEA PERROTTETII F.-Vill.
Crinipellis stipitaria Pers., dead twigs.

LIVISTONA ROTUNDIFOLIA Mart.
Poria (*Porogramme*) *ravenalae* Berk., dead leaf petioles.

MACARANGA TANARIUS (Linn.) Muell.-Arg.
Duportella tristiuscula (Berk.) Pat., dead branches.
Lenzites palisoti Fr., dead bark.

MALLOTUS RICINOIDES (Pers.) Muell-Arg.
Schizophyllum commune Fr., dead branches.

MANGIFERA INDICA Linn.
Duportella tristiuscula (Berk.) Pat., dead branches.
Stereum perlatum Berk., dead branches.

MANIHOT UTILISSIMA Pohl.
Auricularia polytricha (Mont.) Sacc., dead stem.
Schizophyllum commune Fr., dead stems.
Trametes persoonii Mont., dead stems.

MORINDA BRACTEATA Roxb.
Phaeocyphella hibisci Pat., dead branches.

ORYZA SATIVA Linn.
Lentinus braccatus Lév., dead sterile panicles.

PARASHOREA PLICATA Brandis.
Duportella tristiuscula (Berk.) Pat., dead branches.
Polyporus pachyphloeus Pat., dead wood.

PARINARIUM GRIFFITHIANUM Benth.
Duportella tristiuscula (Berk.) Pat., dead branches.

PERSEA GRATISSIMA Gaertn.
Schizophyllum commune Fr., dead wood.

PITHECOLOBIUM DULCE (Roxb.) Benth.
Trametes meyenii Kl., decaying wood.

PREMNA sp.
Duportella tristiuscula (Berk.) Pat., dead branches.

PROSOPIS VIDALIANA Naves.
Crinipellis galeatus (B. et C.) Pat., dead branches.

PSIDIUM GUAJAVA Linn.
Cladoderris caperata Mont. var. *spongiges* (Berk.) Cooke, dead leaves.

PTEROCARPUS INDICUS Willd.
Duportella tristiuscula (Berk.) Pat., dead twigs.

PTEROSPERMUM OBLIQUUM Blanco.
Auricularia tenuis Lév., dead branches.

QUERCUS BENNETTII Miq.
Duportella tristiuscula (Berk.) Pat., dead wood.

SCHIZOSTACHYUM.
Pterula capillaris Lév., dead culms.

SEMECARPUS CUNEIFORMIS Blanco.
Duportella tristiuscula (Berk.) Pat., dead branches.

SOLANUM GRANDIFLORUM Ruiz et Pav.
Auricularia polytricha (Mont.) Sacc., dead stems.

STREBLUS ASPER Lour.
Auricularia polytricha (Mont.) Sacc., dead branches.

STRYCHNOS NUX-VOMICA Linn.
Polyporus rugulosus Lév., dead branches.

TAMARINDUS INDICA Linn.
Duportella tristiuscula (Berk.) Pat., dead branches.
Schizophyllum commune Fr., dead wood.

MYRMECONAUCLEA, A NEW GENUS OF RUBIACEOUS PLANTS FROM PALAWAN AND BORNEO

By Elmer D. Merrill

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MYRMECONAUCLEA genus novum

Flores in capitulum globosum compacti, ebracteolati, calycibus arcte concretis, lobis 5, partes deciduae spathulatae, partes persistentes lanceolatae. Corollae tubus anguste infundibularibus. Stamina in tubo corollae inclusa. Stylus elongatus, stigma subglobosum. Fructus in syncarpium globosum vel depresso-globosum connati, endocarpium superne incrassatum. Semina longe alata. Arbuscula, foliis oppositis, stipulatis; capitulis solitariis, terminalibus bracteatis.

MYRMECONAUCLEA STRIGOSA (Korth.) comb. nov.

Nauclea strigosa Korth. Verh. Nat. Gesch. (1839–42) 157; Miq. Fl. Ind. Bat. 2 (1857) 138; Havil. in Journ. Linn. Soc. Bot. **33** (1897) 52, *t. 2.*

Sarcocephalus fluviatilis Elm. Leafl. Philip. Bot. 4 (1912) 1357.

Neonauclea strigosa Merr. in Journ. Wash. Acad. Sci. 5 (1915) 542.

This characteristic species was originally described from Bornean material, and is at present known only from Borneo and Palawan. Haviland has given an excellent detailed figure of it, and also gives a rather lengthy discussion of it. Korthals had no fruiting specimen, and hence placed it in the genus *Nauclea* (= *Neonauclea*). Haviland followed him in this disposition of it although he indicated that it was anomalous in this genus in that its fruit is concrete and forms a syncarp. I consider that it is as anomalous in *Sarcocephalus*, where it was placed by Elmer, as it is in *Nauclea* and accordingly have proposed a new generic name for it. It differs radically from *Nauclea* auct. (= *Neonauclea*) in its concrete fruits forming a syncarp and as radically from *Sarcocephalus* (= *Nauclea* Linn.) in its winged seeds.

Haviland has discussed somewhat at length the peculiar fruit characters of this species, but he apparently did not have fully mature fruits. In age the persistent tips of the calyx segments

fall, leaving a small perforation at the apex of each individual fruit through which it is apparent that the small, slender, winged seeds escape, dissemination of seeds apparently covering a considerable period of time.

The generic name is derived from the Greek μύρμηκος, ant, and *Nauclea*, a genus to which the present one is closely allied, as a certain percentage of the branchlets always present hollow swellings, perforated on one side, which are inhabited by colonies of small ants.

In habitat the species is exceedingly characteristic, as it always grows on the banks, and on gravel bars in the beds, of small shaded mountain streams, always in places subject to overflow in times of heavy rain; frequently the shrubs stand in constantly running water as does the euphorbiaceous *Homonoia riparia* Lour. It occurs in Palawan at altitudes from sea level to about 300 meters.

I have examined the following material representing the species: BORNEO, Sarawak, Mount Merinjak, *Native collector 2588, 2620* (*Bur. Sci.*). PALAWAN, Alfonso XIII, *For. Bur. 21587 Danao*, April 9, 1914; Caruray, *For. Bur. 27289 Flores;* Taytay, *Merrill Phil. Pl. 1201;* Napsahan, *Merrill 7234;* region of Puerto Princesa, *Merrill 724, Elmer 12848.* The Philippine specimen cited by Haviland as *Vidal 1445* is *Vidal 1448.* It is labeled as from Luzon but in all probability came from Palawan.

COMMENTS ON COOK'S THEORY AS TO THE AMERICAN ORIGIN AND PREHISTORIC POLYNESIAN DISTRIBUTION OF CERTAIN ECONOMIC PLANTS, ESPECIALLY HIBISCUS TILIACEUS LINNAEUS

By Elmer D. Merrill

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Mr. O. F. Cook, of the United States Department of Agriculture, has given considerable attention to the theory of the American origin and the prehistoric distribution across Polynesia of various economic plant species, and has published several papers on the subject. In this series of papers there is considerable evidence that their author is inclined to draw conclusions from insufficient data, involving a lack of personal knowledge of the several species as they occur in nature in various parts of the world, especially in the Old World. It would seem also that, accepting the theory of American origin for a particular species, he is prone to discuss the data in support of that theory, subordinating or overlooking facts that are contrary to the general thesis. The result is that the arguments as presented and the conclusions derived therefrom are not always conclusive, and are certainly not always convincing from either a botanical or a philological standpoint.

He has attempted to prove the American origin of the coconut (*Cocos nucifera* Linn.), and its transmission by the Polynesians across Polynesia to Malaya and tropical Asia in prehistoric times,[1] but more convincing to me are the arguments of Dr. O. Beccari [2] that it is a native of Polynesia or tropical Asia, and that it is a halophilous plant, which may have been disseminated in part by ocean currents.

Beccari, among other criticisms of Cook's arguments, has shown that the palm does occur wild in nature, as witnessed by its unaided development on the isolated and uninhabited Palmyra

[1] The origin and distribution of the cocoa palm, Contr. U. S. Nat. Herb. 7 (1901) 257–293; History of the coconut palm in America, Contr. U. S. Nat. Herb. 14 (1910) 271–342.

[2] Beccari, O., The origin and dispersal of Cocos nucifera, Philip. Journ. Sci. 12 (1917) Bot. 27–43.

Islands, and that it can compete successfully with the arborescent vegetation of tropical strand floras. He has called attention to the fallacy of the statement that Cook makes regarding the plant as seldom growing on the immediate strand, a statement certainly made without sufficient knowledge of the species as it grows in nature; for, as Beccari indicates, the immediate strand is the habitat par excellence for this palm in the vast Indo-Malayan-Polynesian region, as is witnessed by tens of thousands of miles of palm-lined shores in the Philippines and in the Tropics of the Old World as a whole. Again in support of his general thesis that the coconut was not disseminated by ocean currents, Cook illogically argues that the chances are hundreds to one that coconuts falling into the water will be thrown back immediately upon their own coast like other objects floating in the surf, and further that: "High waves or tides, instead of floating shore débris away, merely carry it farther inland, as everybody familar with seacoasts knows." If this be always true, as Beccari notes, we should have to evolve some other theory to explain the geographic distribution of the characteristic elements of the strand floras of the world. The revegetation of Krakatao, so far as its present strand flora is concerned, is in direct opposition to the idea that shore débris is *always* carried farther inland by the waves as Cook infers.

Messrs. O. F. and R. C. Cook [3] have recently made the claim that *Hibiscus tiliaceus* Linn. appears to have been distributed over the islands and shores of the Pacific and Indian Oceans before the arrival of Europeans—a claim that no botanist familiar with the geographic distribution of this characteristic species will dispute. When, however, they infer that the primitive Polynesians were in possession of this species before they became acquainted with similar Asiatic plants; that it may have been carried by them from America across the tropical regions of the Old World; and that, therefore, it is one of the economic plants to be taken into consideration in studying the problem of contacts between the inhabitants of tropical America and Polynesia in prehistoric times, it would seem advisable to present the data in opposition to this argument.

With their first contention, "The maho [*Hibiscus tiliaceus* Linn.] * * * appears to have attained a trans-Pacific distribution in prehistoric times," no fault can be found, as the species is one having a true, and certainly natural, pantropic

[3] Cook, O. F., and Cook, R. C., The maho, or mahagua, as a trans-Pacific plant, Journ. Wash. Acad. Sci. **8** (1918) 153–170.

distribution. We later read: "As with the coconut palm and the sweet potato, the *maho* figures more prominently among the Polynesians than among the natives of tropical America, although the American origin of the plant is *even more clearly indicated*" [italics mine]. The paragraph headings "A wild plant in America" and "A cultivated plant in the Old World" emphasize the fact that the authors are unacquainted with the plant as it occurs in the Old World. All botanists familiar with this common species as it occurs in the vast Indo-Malayan region will at once realize that the last paragraph heading is exceedingly misleading.

They concede that the plant is wild and of wide distribution in tropical America, a region with which they are familiar, where it grows naturally along the seashore; but they make the most curious general claim that it is a cultivated plant in the Tropics of the Old World, a region they have apparently never visited. They admit that in some Polynesian islands it grows spontaneously and covers large areas that have been abandoned after previous cultivation, and that low banks of tidal rivers are its favorite habitat. They do not, however, accept the statements made by numerous botanists, many of whom were familiar with the plant in its native habitat in the Old World, that it is a pantropic strand plant. Their theory regarding *Hibiscus tiliaceus* is apparently based largely on the fact that they know the species from personal observation to be a native strand plant in tropical America, plus the statement in various published works that it is cultivated in Polynesia, and the assumption that it is also cultivated in other parts of the Old World Tropics. This being so, they could then reason its transmission by man from the New to the Old World, and interpret various data in support of that hypothesis.

As a matter of fact, outside of Polynesia the species is never cultivated in the Tropics of the Old World, although one occasionally finds individual trees planted inland for ornamental purposes, while on the islands of the Pacific its cultivation is by no means universal; for here, as elsewhere, it is of wide natural distribution along the seashore, and on many islands (Guam for example) it occurs in enormous quantities forming gregarious thickets near the sea. In tropical Asia and Malaya the plant is not of sufficiently great economic importance to warrant its cultivation, and in these vast regions it is certainly not a species that has purposely been disseminated by man, in either prehistoric or historic times. On some Pacific islands it occurs

gregariously inland, where it sometimes almost exclusively occupies considerable areas, as I have personally observed in Hawaii. The reasons for its cultivation on some Polynesian islands were undoubtedly that it was the best, or one of the best, of the few fiber plants available to the primitive Polynesians, and that the number of plants growing naturally along the strand was not sufficient to supply the demands for fibers for all purposes. *Hibiscus tiliaceus* was never domesticated or even semi-domesticated in tropical America and in the Indo-Malayan region, for the reason that plants producing better fibers were available in both regions.

I maintain on purely botanical evidence that *Hibiscus tiliaceus* is a species of natural pantropic distribution; that it grows in practically all tropical countries along the seashore, its natural habitat; and that it has been disseminated in ages past by ocean currents. Its seeds are beautifully adapted to dissemination by floating for, although small, they are provided with a smooth impervious testa, and float for many months without sinking. In fact, no one has as yet recorded his ability to cause them to sink naturally, investigators being satisfied from experimentation with the statement that they "float for months."

Even in Polynesia it is exceedingly doubtful if the Polynesians transmitted this species from island to island, it being far more probable that they purposely propagated it inland from the native seacoast stock on the various islands. From personal experience over a period of more than eighteen years I am familiar with the entire Philippine group from northern Luzon to southern Mindanao, and have observed that throughout these islands *Hibiscus tiliaceus* is a characteristic species of the seashore, often being the dominant, or one of the dominant, species on the strand; it occurs not only on beaches contiguous to thickly settled areas but also on isolated and sparsely populated coasts, and on uninhabited islands and islets. From what I know of the Indo-Malayan region generally I am confident that the species occurs similarly on the tens of thousands of miles of coast line throughout tropical Asia, Africa, Malaya, tropical Australia, and many islands of the Pacific, as I have personally observed it in the Philippines and in the Marianne Islands. There can scarcely be any arguments as to other than its natural pantropic distribution, and claims to the contrary would appear to be not in conformity with the known facts regarding its occurrence and distribution in nature.

Being thoroughly familiar with *Hibiscus tiliaceus* as it occurs in nature in the Old World, it is difficult for me to conceive how any botanist could seriously advance the argument that it is a native of tropical America transmitted to the Old World by the primitive Polynesians and, as a corollary, attempt to prove intercommunication between Polynesia and tropical America in prehistoric times on the basis of the present pantropic distribution of this species. That a limited intercommunication between Polynesia and tropical America did exist in prehistoric times is entirely probable, but to argue that the present distribution of *Hibiscus tiliaceus* supports this theory certainly does not strengthen the probability.

The generally accepted theory among ethnologists supports an *eastward* culture movement across the Pacific rather than a *westward* one. If the Cook *maho* series is related to the Polynesian *mao* series it would be much more reasonable to view it as coming from the Pacific to America rather than as evidencing a migration from America into the Pacific. If, as they claim, the American origin of *Hibiscus tiliaceus* is *even more clearly indicated* than is the similar origin of the coconut and the sweet potato, the claims to the American origin of the last two must be very weak indeed.

Their argument regarding the origin and distribution of *Hibiscus tiliaceus* is largely based on the similarity between its local names in tropical America and in Polynesia; namely, *maho, mahagua,* etc., in tropical America, and *mao, mau, vau,* etc., in Polynesia. About thirteen pages are devoted to a discussion of the philological questions involved. While many data are given to show the similarity of names in tropical America and Polynesia, it is stated that the names used in Fiji, Guam, and the Philippines may not belong to the *maho* series. The large number of Malay Archipelago names is ignored, but the statement is made that local names used in Madagascar and the neighboring islands appear to connect with the Malay and Polynesian series.

The recorded names for the species in the Philipipnes are *bago, bauan, balobago, balibago, malabago, malabagu, malambago, mayambago, mulabago, danglog, loago, hanot,* and *hanut;* of these *balibago* and *malabago* are the ones most commonly and widely used. The recorded names for the Malay Archipelago, not mentioned by Cook, are *balebirang, baoe, baoek, baroe, baroe bhender, haoe ai, haroe, kabaroe, kalimbaoean, kasjanaf, kawaoean, kelambaoean, kioko, lago, molombagoe, molowahoe, papatpat, pohon baoek, siroen, wahoe, wande, waoe, waroe, waroe*

laoet (*laoet*=ocean), *waroe lenga*, and *waroe lengis*. These names are from Dutch sources, and it should be borne in mind that in Dutch orthography *oe* represents the sound *u*.

As noted above, the authors state that it may be doubted whether names like *vahu*, *balibago*, and *pago*, used in Fiji, the Philippine Islands, and Guam, belong in the *maho* series, but consider that the relation seems possible in view of the intermediate Polynesian forms like *bago*, *faga*, and *haga*. They do not discuss the Malayan names enumerated above, but with the statement that they appear to connect with the Malayan and Polynesian series they list the following names from Madagascar and neighboring islands: *baro*, *var*, *varo*, *vau*, and *vaur*. Among the names in use in India, *bariá* and *baru* are suggestively like many of the Malayan, Mascarene, and Polynesian names.

Not being qualified personally to discuss the philological questions involved, and yet confident on purely botanical grounds that *Hibiscus tiliaceus* is a strand plant of natural pantropic distribution, at my request Prof. H. Otley Beyer, of the department of anthropology, University of the Philippines, and Mr. E. E. Schneider, of the Philippine Bureau of Forestry, have examined Cook's paper and my notes on which this article is based. Both of these men are authorities on Philippine languages and both are deeply interested in the comparative philology of Indo-Malayan, Philippine, and Polynesian languages. Professor Beyer, whom I first consulted, has called my attention to the fact that the Polynesian *mao* series may well have been derived from some of the Malayan forms by the suppression of consonants, which is a fundamental characteristic of the Polynesian group of languages as contrasted with the Malayan languages. It seems to me to be entirely probable that the original form or root in the Indo-Malayan region was some word like *bago* or *baru*. It is to be noted that with the substitution of *m*, *f*, and *v* for the initial *b*, and *h* for *g* or *r*, or the suppression of the latter two letters, we have a series of names that approximate the Polynesian *mao* series given by Cook as *mao*, *mau*, *au*, *hau*, *fau*, and *vau*. The probabilities are very great that all of the Polynesian *mao* series are merely modifications of the Indo-Malayan *bago* series; and that the Polynesians in their migration, having adopted the name while in the Indo-Malayan region, merely applied it to the wild plant which they found all over Polynesia. It would seem, therefore, that this root has nothing to do with the tropical American *maho* series, the resemblances being merely accidental. The *bago* origin of the *mao*

series is a great deal more likely than the *maho* origin, and infinitely more probable in view of the generally accepted theories as to the origin and migrations of the Polynesians. It is, moreover, not, as these authors contend, in violent opposition to the known distribution and occurrence in nature of the species under discussion.

Mr. Schneider is in full agreement with the *bago* or *baru* origin of the Polynesian *mao* series. He considers that one of the weakest spots in Cook's argument is the expressed doubt that the Fijian *vahu,* the Philippine *balibago,* and the Guam *pago* belong to the *mao* series. He states that the very wide distribution of the *bago* form in the Indo-Malayan region indicates that it is as near as we can get to the original root, whatever that may be. The fact that *r, g,* and *h* are interchangeable in certain series of words in most of the Indo-Malayan languages is as well established as is any of Grimm's laws in the European languages. He considers that there can be hardly any doubt that the Indian *baru* is identical with the Philippine *bago.* The final disappearance of the *h* when intervocalic is not uncommon in Tagalog and in other Philippine languages. Guam *p* for Philippine *b* is perfectly regular, as is *v.* Finally, the weakening of initial *b* to *m* is very common—for example, the plant names *banaba, manaba; binunga, minunga; batavia, matavia;* and, as to *malabago* itself, this is apparently nothing but a reduplicated form with weakened initial *b,* of which other examples are to be found, such as *matobato.*

As to the meaning and application of the name *maho* Mr. Schneider further points out that, whether it was originally the name of some bast-producing plant that was also applied to others that either produced bast or resembled them in external appearance, or a word primarily meaning "bast" and "to tie," is perhaps a question which cannot be decided and, moreover, is of no great importance. The wide distribution of the word has nothing to do with this, however, the following notes indicating what seems to him to be a more probable alternative, namely, that "bast" is the original meaning of the word *maho. Bago,* to use now a Philippine name, is one of the most commonly used names for *Gnetum gnemon,* the bast of which is probably the strongest found in the Philippines and used wherever very strong cordage is desired. *Salago,* in which the same root occurs, is widely used for species of *Wikstroemia* and *Phaleria,* both producing a very fine and extremely tough bast. A parallel case is that of the other name, *hanot,* cited above for *Hibiscus*

tiliaceus; this, in very numerous forms, of which *banot, bonot, lanot, lanutan, wanoet* (Dutch spelling), *lapnot,* and *lapnit* are a few, is applied to even more numerous species of plants than is *bago,* but also invariably to plants producing some kind of bast fiber or tying material. Examples from widely different plants to which these names are applied are species of Annonaceae; representatives of Malvaceae; various species of vines, representing diverse families, which may either be used whole or which produce bast (*Bauhinia cumingiana*); palms having a network of fibers about the bast of leaf stalks; coir; the epidermal layers from the leaf sheaths of abacá (*Musa textilis*); and finally rattans. Mr. Schneider considers that these cases seem to indicate the derivation of the plant names from a common property rather than the derivation of names of various plants from a primitive or original name of a single species. Is not the American bass wood (bast-wood!) a perfectly analogous case?

It would seem that the argument of these authors as to the American origin of *Hibiscus tiliaceus* and its prehistoric distribution across Polynesia by the Polynesians to the Tropics of the Old World was based on erroneous assumptions on their part, from both a botanical and a philological standpoint, and that their deductions are not borne out by the facts in the case.

AN ATYPICAL AMŒBA CAUSING DYSENTERIC LESIONS

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THREE COLORED PLATES

Although many of the findings of Schaudinn(5) on *Entamœba histolytica* and *E. coli* have since been controverted by subsequent observers, that portion of his work on *Entamœba histolytica* in which he has proved that it is the sole pathogenic species in man, all others being nonpathogenic, has received ample confirmation from workers in all parts of the world. In fact, by the term amœbic dysentery we understand dysentery caused by *Entamœba histolytica* Schaudinn. Viereck's *Entamœba tetragena* and Elmassian's *E. minuta* have been proved to be phases of *E. histolytica*. Hartmann's *Entamœba africana* has been proved to be identical with the "tetragena phase" of *E. histolytica*. Accordingly, the importance of finding an amœba causing fatal dysenteric lesions and differing from the classical pathogenic species in its nuclear and other characters can well be appreciated.

The patient, from whom the material forming the subject matter of the present paper was obtained, was admitted to the Medical College Hospital, Calcutta, in a moribund condition. He died a few hours after admission. At the autopsy, which was held three hours after death, the large intestine was found inflamed and ulcerated throughout. A portion near the rectum was in a sloughing condition. In parts not so severely affected were found small, circular, elevated ulcers in the middle of which there was a central slough—an appearance which is well known as pathognomonic of amœbic dysentery. Near the cæcum, some coils of intestine were found matted together. However, no distinct perforation could be made out. A peculiarity not ordinarily found in amœbic dysentery was a large elevated inflammatory patch on the peritoneal surface of the wall of a portion of the intestine that was matted together. A smear was made from this inflamed patch on the peritoneal side, and this was examined microscopically. I was surprised to find numerous

actively motile amœbæ. On forcibly opening the adherent coils of the intestine, a large collection of creamy pus was found inside the cavity formed by the adherent coils of the intestine. The pus cavity was found completely surrounded by the coils; no opening joining the cavity with the lumen of the intestine could be discovered. Smears of the pus showed numerous actively motile amœbæ. On staining the smears the pus was found to be free from other microörganisms. Several stained preparations were made from this pus. Another peculiarity found in the case was the presence of dysenteric lesions in the small intestine extending about 3 inches above the ileocœcal valve. Three typical dysenteric ulcers were found in this area. Lastly, an elongated, elevated, inflammatory patch was found on the peritoneal surface of the small intestine opposite the ulcers—the appearance being similar to that found in the large intestine. Smears from this patch showed an abundance of living amœbæ, while smears from the other portions of the peritoneal surface of the intestine showed no amœbæ. A portion of the affected small intestine and large intestine were removed for sectioning.

CHARACTERS OF THE LIVING AMŒBA

In fresh preparations made with pus taken from the pus cavity, numerous actively motile amœbæ were found. As it was not possible to stain preparations at the time that this examination was made, it was not suspected at the time that the amœba differed altogether from the classical type, and accordingly no special attempt was made to make out any distinctive characters of the living amœbæ. All that I remember was that the amœbæ showed marked size differences. Some of them were vacuolated. The ectoplasmic and endoplasmic differentiation was notably marked.

STAINED PREPARATIONS

Stained preparations were made by making films, fixing them while still wet in acetic acid-picric acid solution and then staining them by a modification of Dobell's iron-hæmatein method. The slides were stained overnight and then differentiated by ferrous alum solution under microscopic control. On cursory examination of these slides under the oil-immersion objective I noticed that the nucleus of the amœba was not of the karyosomic type. On carefully examining a large number of individuals in the several preparations I made, I found the amœbæ showed the following characters:

There was marked variation in the size of the amœbæ, the predominant range being from 16 μ to 20 μ. Many measured from 30 μ to 40 μ. A few were as small as 8 μ. As remarked before, the nucleus was not at all of the *histolytica* type. In most cases, it was oval and quite unlike the circular ring of the *histolytica* nucleus. Plate 1, figs. 1 and 5, show the type of nucleus I found in most cases. It is sometimes rounded (Plate 1, fig. 7). It is situated eccentrically as in *Entamœba histolytica*. There is no differentiation into central and peripheral chromatin. No karyosome is seen. The nucleus stains uniformly dark, and, in some cases, an elongated, unstained patch is seen near the periphery of the nucleus (Plate 1, fig. 6), but in most of the specimens the chromatin and the plastin form a uniformly stained mass. The nuclear membrane is not easily distinguished. In fact, the nucleus is of the "limax" type. It differs from it in not being so dense. It differs from the nucleus of the trophozoite of *Entamœba nana* as described by Wenyon and O'Connor(7) and by Kofoid, Kornhauser, and Swezy(4) in that the chromatin substance is not clumped together at one point on the nuclear membrane leaving the remainder of the nucleus clear. In some of the larger specimens (those measuring 32 μ to 40 μ) the nucleus showed evidence of division by mitosis. Even in division, no separation between peripheral and central layers of chromatin could be distinguished, the entire nucleus being stained uniformly.

In the structure of the cytoplasm this amœba shows well-marked, distinctive characters apart from that of *Entamœba histolytica*. In the former there is a striking distinction between the ectoplasm and the endoplasm. Now, this very character is one of the points of distinction between *Entamœba histolytica* and *E. coli;* but by comparing *Entamœba histolytica* with the amœba under consideration, it will be found that the differentiation between ectoplasm and endoplasm is much more pronounced in the new amœba than it is in *E. histolytica*. In the resting condition of the latter, no noticeable distinction between endoplasm and ectoplasm can be made out, but this is not the case with this amœba. Even in the resting condition a clear, glistening ectoplasm is seen surrounding the stained endoplasm. In the moving specimen during pseudopodium formation this distinction is much more pronounced (Plate 1, fig. 10). The structure of the endoplasm is alveolar in most cases; in a few vacuolation is found (Plate 1, figs. 6 and 8). In a few individuals red blood corpuscles and, in some instances, bacteria

were seen to have been ingested (Plate 1, figs. 4 and 13). In none of the specimens were any chromidia blocks seen—a character commonly found in examining specimens of *Entamœba histolytica.*

In order to exclude any source of error due to faulty technic, I had recourse to the following procedure: I made several preparations from different samples of dysenteric stools and passed them through the same fixing and staining processes as the preparations under consideration. On examining the former I had not the slightest difficulty in recognizing the clear, circular *histolytica* nucleus. Furthermore, in bringing out the distinctive points in the characters of this amœba and those of *Entamœba histolytica* I had, for comparison, some permanently mounted specimens from the pus of a case of liver abscess in which there were abundant amœbæ, each field showing fifteen to twenty individuals. The nuclei in these showed all the possible variations described by various authors as cyclic changes. No extreme variation in the shape of the nucleus of *Entamœba histolytica* is comparable to the nucleus of this amœba.

STUDY OF SECTIONED MATERIAL

As noted before, I made sections through the affected portions of the small and large intestines. These were hardened in alcohol and then embedded in paraffin. The sections were stained in the same way as the smears. A few were stained by Ehrlich's hæmatoxylin, but as these failed to differentiate the amœbæ, this method was given up.

I sectioned through two portions of the small intestine (Plate 2, fig. 2, and Plate 3), one in which there was an ulcer and another in which there was no discontinuity of the mucous membrane. In both, the peritoneal surface showed the lesion seen in fresh material by the unaided eye. I shall describe the peritoneal lesion first as great interest attaches to it. I am not aware of any inflammation of the peritoneum that can be attributed to amœbæ. Moreover, this amœbic peritonitis, if I may be allowed to coin the term, differs entirely from ordinary peritonitis and is, therefore, a distinct pathological entity. This lesion, which was caused by the amœbæ, showed, when the material was fresh, a distinct red elevated patch, in the scrapings from which I found numerous amœbæ. When a stained section of this portion of the small intestine was studied under a low power this patch was noticed to be stained distinctly less faintly than the rest of the tissue (Plate 3, *a*). The thickness of the patch, as will be seen, nearly equals the combined thickness of

the transverse and longitudinal muscular coats of the intestine. On examination under high power, it was found to be composed of a dense collection of cells interposed among a granular débris. Between the small faintly stained cells a few large irregularly shaped cells were found under the oil-immersion lens. These were the amœbæ. No collections of red blood corpuscles, or leucocytes, or fibrin threads—so characteristic of inflammatory lesions caused by microörganisms—were found.

Interposed between this faintly stained cellular layer and the longitudinal muscular coat was found a layer of tissue that was very vascular and which took the stain deeply (Plate 3, *b*). This was evidently the subperitoneal tissue. On its outer boundary was seen a layer of cells, evidently the endothelial lining of the peritoneum. Careful study of this vascular subperitoneal layer under the oil-immersion lens showed it to be composed of numerous engorged vessels. The intervening tissue outside the vessels was full of a granular débris, among which were found several large cells. The outlines of these could only be clearly distinguished by constantly changing the focus. These cells showed a single eccentrically placed nucleus. In some, the nucleus could not be seen. In some, obscure vacuolation was observed. They were much larger than the leucocytes. These, I have satisfied myself, are the amœbæ. On examining the muscular layer, no abnormality was found except infiltration by granulation cells although here and there fragmentation of the muscle was encountered. On examining the mucous and submucous coats of the small intestine the vessels of the latter were found to be very much engorged (Plate 3, *f*). Numerous collections of granulation cells were found, but I failed to discover any cell having the appearance of an amœba. In the mucous layer, the mucous glands were seen to be embedded in a cellular infiltration. The portion of the glands abutting on the lumen was found obliterated and it had been replaced by a cellular infiltration and by hæmorrhagic patches. On carefully examining the infiltrated mucous membrane with the oil-immersion lens, I failed to find any cell resembling an amœba except among the hæmorrhagic patches. In these hæmorrhages are found big amœboid cells surrounded by erythrocytes. Plate 2, fig 2, is a representation of one of these patches as seen under the oil-immersion lens.

On studying sections of that portion of the large intestine which was found embedded in the abscess cavity, no trace of the mucous coat could be distinguished. A considerable portion of the muscular coat had been replaced by granulation cells em-

bedded among which were found engorged capillaries. In one of the vessels I found numerous amœbæ collected within the lumen of the capillary in which were also found leucocytes, red blood corpuscles, and remnants of the shed endothelial lining of the vessels. This finding of the amœbæ inside the capillaries indicates the way the amœbæ spread through the tissues, that is, by the vascular system.

The question now arises as to whether this amœba is a new one. It is evident from the description given above that it cannot by any means be classed as *Entamœba histolytica.* As no other amœba has been proved to be pathogenic, the one under consideration is then a new pathogenic species. It is necessary, however, to compare the structure of this amœba with other species that have been found in human fæces by other observers. I need not refer, in this connection, to the large number of ill-defined species of amœba described by writers who did not use modern staining methods. The only types to which this amœba has resemblance are *Vahlkampfia* (*Amœba*) *limax* and *Entamœba nana. Vahlkampfia limax* found in human fæces as described by Wenyon(6) is a very small organism that does not measure more than 10 μ in diameter. Furthermore, the nucleus is situated centrally and is spherical. There is no differentiation between the ectoplasm and the endoplasm so far as can be seen. It then becomes necessary to compare this species with *Entamœba nana,* for this variety has been found recently to be very common throughout the world. It has been reported from Egypt, England, the United States,(3) the Philippine Islands, and other places. Most of those who have reported on it are agreed that it is nonpathogenic. From the description of the species as given by Kofoid, Kornhauser, and Swezy(4) we find that the nucleus has a massive karyosome that is situated on one side of the nuclear membrane, the remainder of the nucleus being empty. *Entamœba nana,* as described by Dobell and Jepps, (2) has a fragmented karyosome. These descriptions differ from the nuclear structure of the amœba under consideration. Furthermore, the characteristic distinction between the ectoplasm and endoplasm, which is a very prominent character in my amœba, has not been found in the other two amœbæ. Moreover, these being nonpathogenic, they cannot be the same species as this one.

As no cyst has been found by me, it is not possible for me to compare these amœbæ with respect to their encysted forms.

RÉSUMÉ AND CONCLUSIONS

I have discovered an amœba causing fatal dysenteric lesions in man and differing from *Entamœba histolytica* in the following essential points: (1) The nucleus is massive—not karyosomic; (2) there is marked distinction between ectoplasm and endoplasm; (3) chromidia are absent.

The lesions caused by this organism differ from those familiar in dysentery of *Entamœba histolytica* origin, in that the small intestine is attacked—a phenomenon heretofore absolutely unknown in dysentery of entamœbic origin. Furthermore, the peculiar peritoneal involvement is a unique thing.

The amœba differs in important morphological details from both *Entamœba nana* and *Vahlkampfia* (*Amœba*) *limax.*

In asserting that this amœba is a new species I suffer under the difficulty that I have to draw my deduction from a single case. To ascertain whether it is a purely local variety hitherto unobserved, I have studied many permanent preparations that I have made from numerous stools from dysentery patients as well as from pus from liver abscesses, which I have had the opportunity to examine during the past six years that I have been studying the intestinal protozoa. In no specimen studied could I find any amœba showing a nuclear or cytoplasmic structure similar to that of the amœba I have found. Other workers in India who have studied the structure of amœbæ found in human fæces and who have used recent staining methods, among them Cragg(1) and Knowles and Cole, do not mention having come across any variety of amœba other than *Entamœba histolytica* and *E. coli.*

Therefore, it seems evident that this is a new species. The next question is, to what genus it should be assigned. According to Schaudinn and to Doflein, the genus *Entamœba* is characterized by a parasitic mode of life, movement by "Lappige" [lappenförmige?] pseudopodia and by transmission to other hosts in cysts. This amœba can then be classified under the genus, although I have not been able to demonstrate the encysted stage.

I designate this amœba *Entamœba paradysenteria* sp. nov. This name, of course, may later be dropped if the organism is determined to be a species already described.

REFERENCES

(1) CRAGG, F. M. A contribution to our knowledge of Entamoeba coli. Indian Journ. Med. Res. 26 (1919) 462.

(2) DOBELL, C., and JEPPS, M. W. On the three common intestinal entamœbæ of man and their differential diagnosis. Brit. Med. Journ. 2 (1917) 607.

(3) KOFOID, C., A., KORNHAUSER, S. I.; and PLATE, J. T. Intestinal parasites in overseas and home service troops of the U. S. Army. Journ. Am. Med. Assoc. 72 (1919) 1721.

(4) KOFOID, C. A.; KORNHAUSER, S. I.; and SWEZY, OLIVE. Criterions for distinguishing the endamœba of amebiasis from other organisms. Arch. Int. Med. 24 (1919) 35.

(5) SCHAUDINN, FRITZ R. Untersuchungen über die Fortpflanzung einiger Rhizopoden. Arb. a. d. Kaiserl. Ges.-Amt. 19 (1903) 547.

(6) WENYON, C. M. The common intestinal protozoa of man. Lancet 2 (1915) 1173.

(7) WENYON, C. M., and O'CONNOR, F. W. Journ. Roy. Army Med. Corps. 28 (1917) 346.

ILLUSTRATIONS

[Drawings by B. L. Das.]

Plate 1

Smears from pus. The specimens were fixed in a moist state in aqueous picric acid solution and stained by Dobell's modified iron hæmotoxylin stain. Drawn under 1/12 inch apochromatic lens with No. 6 eyepiece.

Fig. 1. Type of nucleus. Figs. 1, 3, and 6 show types of nuclei that are predominant in smears taken from pus found in the abscess or from ulcers in the small and in the large intestines. Note the striking difference between these nuclei and that of *E. histolytica*.

2. A rounded nucleus. The oval body in the right corner is probably the remnant of an engulfed erythrocyte.
3. An amœba in the motile stage: *n* is the nucleus, the other bodies are cell inclusions.
4. An amœba in resting condition.
5. An amœba, showing the characteristic nucleus.
6. An amœba, showing a rounded nucleus with a layer of clear cytoplasm surrounding it. The elongated body at the left corner is a remnant of an engulfed erythrocyte.
7. An amœba with dense rounded nucleus. This appearance is not common.
8. Two amœbæ of markedly different sizes. The cytoplasm shows well-marked vacuolation.
9. Two amœbæ with well-marked ectoplasm.
10. An amœba in the motile stage, showing marked differentiation between ectoplasm and endoplasm.
11. An amœba with the nucleus showing a central body like a karyosome; this is probaly an artefact.
12. An amœba in motile condition.
13. An amœba showing no differentiated ectoplasm; *a*, the nucleus; *b*, a cell inclusion.

Plate 2

Fig. 1. Part of an amœba drawn under 1/12 inch apochromatic lens and No. 18 eyepiece; *n* is the nucleus; the characteristic unstained patch is clearly seen. The protoplasm is vacuolated. *e* is the ectosarc.

2. A section of tissue drawn under 1/12 inch oil-immersion lens and No. 6 eyepiece. *a*, a capillary vessel containing three amœbæ; *b*, an amœba in the tissue.

PLATE 3

A section of tissue drawn under low power. *a*, the exudation on the surface of the peritoneum. *b*, the subperitoneal tissue. *c*, points to longitudinal muscular coat. *d*, to transverse muscular coat. *e*, points to submucous tissue. *f*, points to a hæmorrhagic patch on the surface of the mucous membrane. This portion has been drawn under 1/12 inch oil-immersion lens and No. 6 eyepiece in Plate 2, fig. 2.

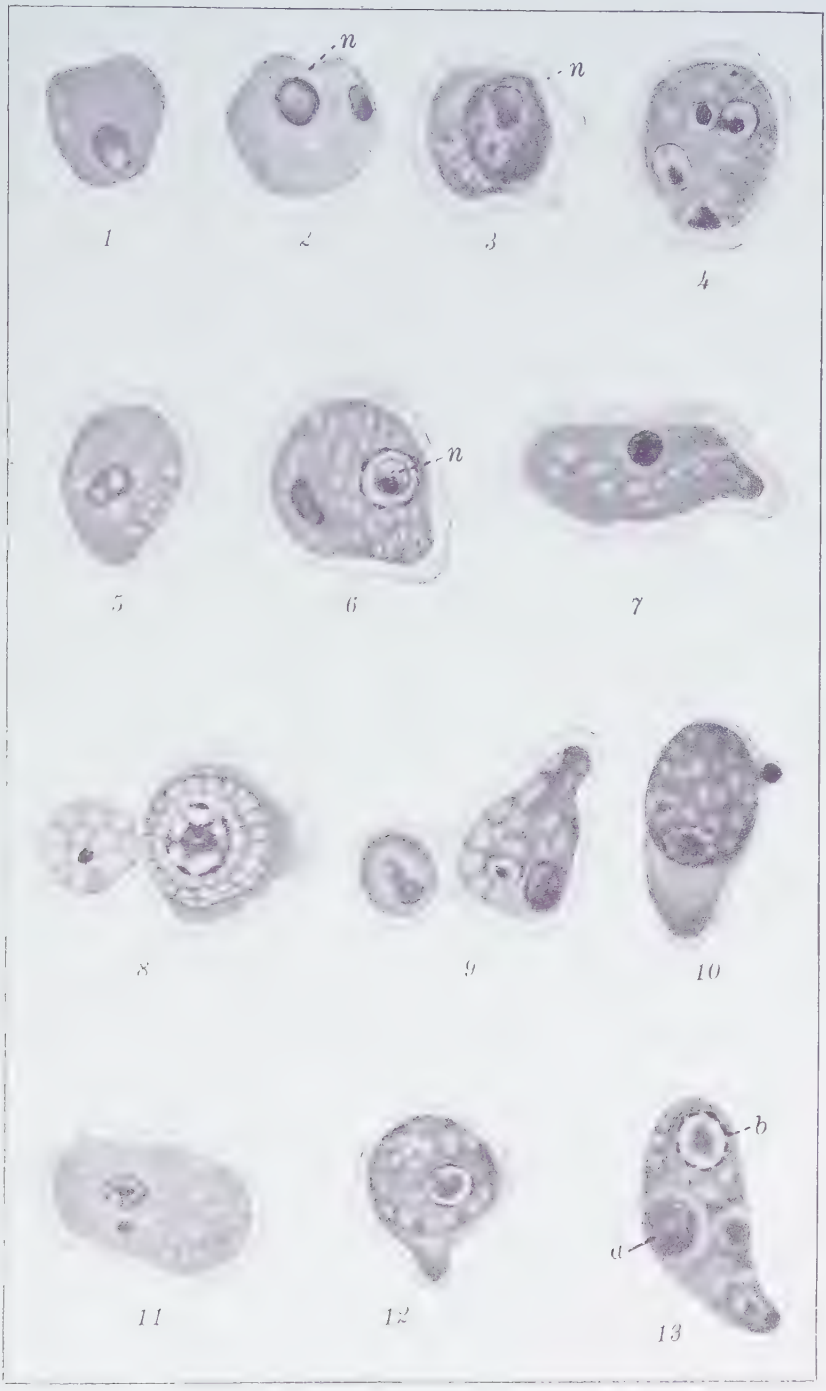

PLATE 1. VARIOUS STAGES OF THE AMŒBA.

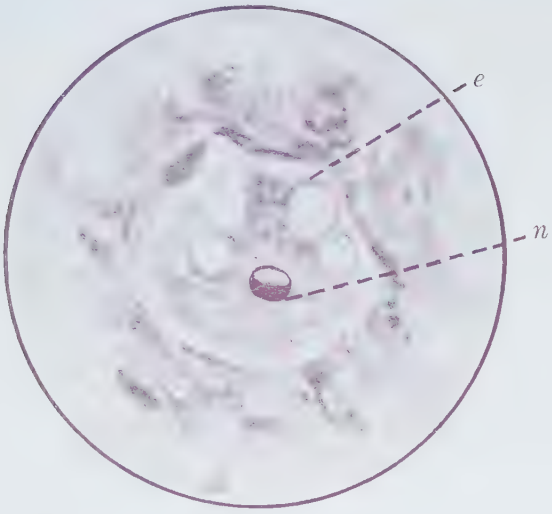

Fig. 1. Part of an amœba.

Fig. 2. A section of tissue containing amœbæ.

PLATE 2

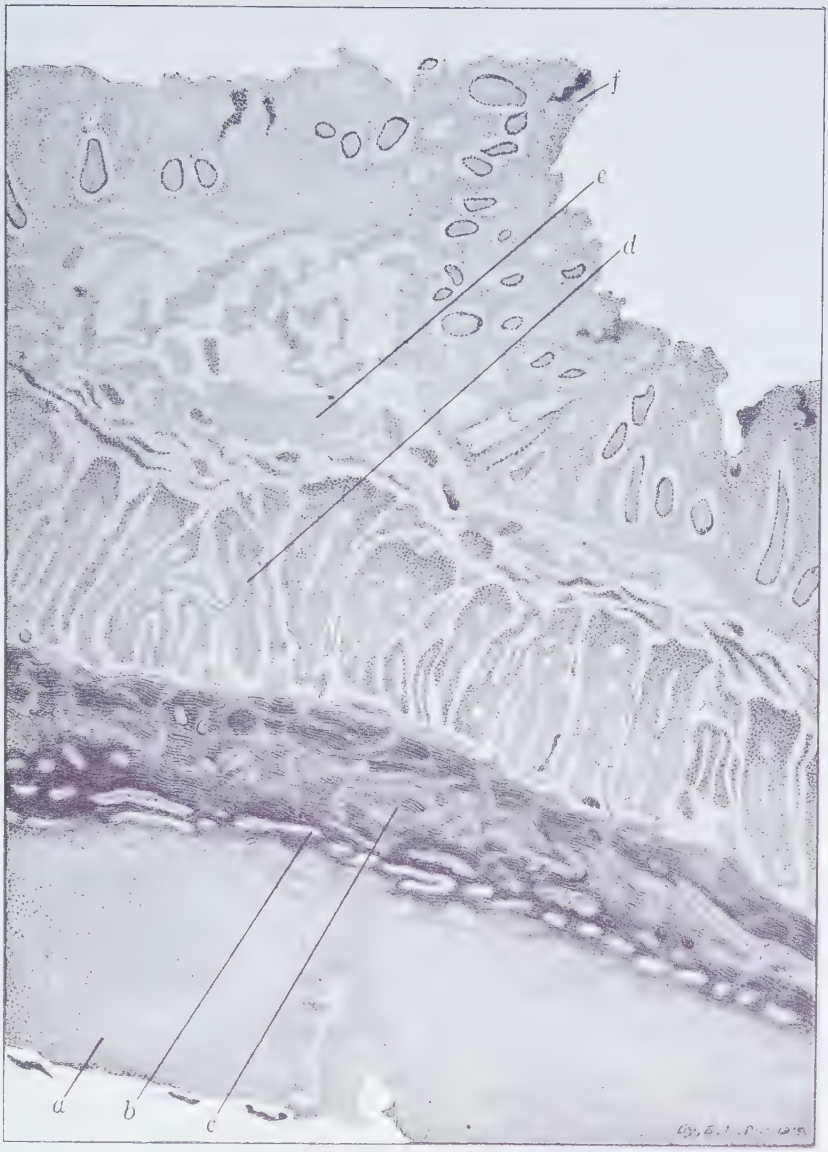

PLATE 3. A SECTION OF TISSUE UNDER LOW POWER.

THE UTILIZATION OF WASTE MOLASSES IN THE PHILIPPINE ISLANDS

WITH SPECIAL REFERENCE TO THE HACIENDAS OF NEGROS [1]

By H. J. Carsten

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The disposal of waste molasses has been a troublesome problem to the modern sugar manufacturer; and on Negros Island, with centrals springing up like toadstools, the difficulty is enhanced.

Several schemes have been tried and, although they have helped to some extent, it has been practically impossible up to the present time to use all of the molasses produced. The following are some of the ways in which this product has been used:

1. As fuel, in conjunction with bagasse.
2. As fuel, separately.
3. For the manufacture of alcohol and the recovery of potash from the waste.
4. The solidification of molasses.
5. Manufacture of cattle feed or easily transportable molasses.
6. The manufacture of fuel gas.
7. The manufacture of sugar by the Steffen process, as modified by Battelle.
8. The manufacture of char and recovery of the potash.
9. The manufacture of acetate of lime.
10. The manufacture of glycerin by fermentation.

1. THE BURNING OF MOLASSES IN CONJUNCTION WITH BAGGASSE AS FUEL

The use of molasses as a fuel in conjunction with bagasse is limited. Certain mixtures of bagasse and molasses cause the formation of clinkers, which results in the burning of the grates. In most factories, where this practice was begun, it was later abandoned on account of the burning of the grates, damage to the brickwork, or because of the trouble encountered in cleaning the fire boxes.

2. THE BURNING OF MOLASSES SEPARATELY AS FUEL

Molasses has been used by itself as fuel. One of the methods was to spray it into the fire box under steam pressure. How-

[1] Received for publication, July 21, 1919.

ever, the steam needed for the spraying just about offset the extra steam obtained by the use of the molasses as a fuel.

Molasses has been burned in Steele ovens. In this process it is allowed to run over inclined plates, where it comes in direct contact with the hot gases from the fire. The molasses becomes charred on its way to the grates and, once ignited, maintains the fire. The gas created is often sent into the bagasse furnaces to be burned there. Sometimes the charred molasses is treated in a current of air and steam, making producer gas which is utilized for power.

When the molasses is burned by itself, it is of course possible to recover the potash. However, this process is profitable only when the factory uses the potash in the soil; a very high market price for potash could make this process profitable commercially.

In all burning processes, valuable materials are invariably lost; namely, sucrose, glucose, and fructose, which form about 55 per cent of the weight of the molasses.

3. THE MANUFACTURE OF ALCOHOL AND THE RECOVERY OF POTASH FROM THE WASTE

In the manufacture of alcohol the three substances sucrose, glucose, and fructose do not constitute waste because they are converted into alcohol. Eventually it is possible to recover the potash from the waste, so that all valuable materials in the molasses are recovered when it is used in making alcohol. This utilization of waste molasses is of especial interest at the present time, because alcohol, when properly denatured, becomes an economical fuel for farm tractors used in cane fields. It may be of interest to state here that many of the planter's troubles—such as rinderpest, shortage of labor, and delayed planting—can be avoided by the use of tractors.

On Negros Island the area available for sugar planting could produce, say, 500,000 tons a year; about 200,000 tons are produced at present. Estimating that 10 tons of cane will produce 1 ton of sugar, and that 1 acre will yield 20 tons of cane, 100,000 acres (about 40,350 hectares) will produce 200,000 tons of sugar. The molasses weight is about 25 per cent of the weight of the sugar produced; therefore, 200,000 tons of sugar would yield 50,000 tons of molasses which, at 12 pounds to the gallon, amounts to 8,333,333 gallons. Taking the high figure of 3 gallons of molasses to 1 gallon of alcohol at 180° proof, we find 2,777,777 gallons of alcohol as the possible yield from the waste molasses now produced yearly in Negros.

The gasoline consumed by an ordinary, light tractor is about 8 gallons per hectare for plowing. For the yearly crop on Negros Island, the plowing would take 322,800 gallons of gasoline which at 10 pesos per case, amounts to 322,800 pesos.

In estimating the quantity of alcohol that an engine equipped for alcohol consumption would require to plow 40,350 hectares of land, it is said that: [2]

Although the heat value of alcohol per pound is comparatively small (11.178 B. T. U. per pound), yet on account of the heaviness as a vapour, and the small volume of air required to burn it compared with benzine and gasoline, it yields 89.2 B. T. U. per cubic foot of mixture at 60° F. and atmospheric pressure. Moreover, the products of combustion are six and one half times greater than the volume of the unburnt mixture, with corresponding increase in the pressure developed. There is thus, thermally considered, not very much to choose between alcohol and gasoline; alcohol is, in fact, an excellent fuel for suitably designed internal-combustion engines, and is largely used in Germany where its production is encouraged by the Government; in 1904 the price of alcohol in Germany was only 30 cents per gallon when purchased in large bulk.

Alcohol engines require larger carburettors, piping, and valves than are necessary when gasoline is used. As the latent heat of alcohol much exceeds that of petrol, especially when water is present in any considerable proportion, it is also necessary to jacket the carburettor with hot water or exhaust gas and to heat the ingoing air to about 350° F. in order to ensure complete vaporization. The cylinder jacket water should also be kept at nearly 212° F.; too cool a cylinder results in imperfect combustion of the mixture, because of the formation of acetic acid, aldehyde, etc., instead of carbon dioxide and water only, causing loss of efficiency and the corrosion of internal parts. Starting up from cold is a special difficulty with alcohol, and engines are usually started with gasoline, the alcohol being turned on when everything is well warmed up.

Some engines are arranged so as to start and stop on gasoline; in this way any traces of water or acid from the alcohol are cleared out of the cylinders and passages, during the last few revolutions of the engine, and corrosion of parts is thus avoided.

Test on a 14 H. P. "Locomobile" alcohol engine of 8.28" bore and 11.8" stroke made by Prof. E. Meyer in 1901, showed a brake thermal efficiency of 24 per cent, using alcohol containing about 13 per cent water. The volume ratio of compression was 5.9. The cylinder jacket water temperature was maintained at 208° F. The engine ran at 280 revolutions per minute and developed 13.9 C. H. P. [B. H. P. ?] at full load.

In round numbers, it takes 1.85 pounds of alcohol as against 1 pound of gasoline. Assuming the gasoline specific gravity to be 0.72, 1 pound of gasoline would equal 0.167 gallons; and 1.85 pounds of alcohol with a specific gravity of 0.8228 would equal 0.268 gallon. Therefore, 322,800 gallons of gasoline will develop the same number of British thermal units as 517,771

[2] From the Engineer's Year Book for 1916.

gallons of alcohol, the quantity necessary to plow one crop in Negros.

Taking the value of gasoline at 10 pesos per 10 gallons, the value of the alcohol per gallon would be 61.79 centavos. At the present market price of gasoline, 14 pesos per case, the value of the alcohol would be 86.5 centavos per gallon.

Obviously, plowing will not require the consumption of the total yearly yield of 2,777,777 gallons of alcohol; but harrowing and cultivating can also be done by power developed from alcohol, except when the cane gets too tall, when such work will have to be done by man and animal power or, possibly, by a specially designed machine. The amount of alcohol available is at least four times that required for plowing. Even if two plowings and one harrowing should require three times the quantity (517,771 gallons) the total consumption would amount to 1,553,313 gallons and there would still be a surplus of 1,224,464 gallons of residual alcohol.

On a plantation where tractors are used the alcohol left after plowing and harrowing might be utilized in motor-driven pumps for irrigating, for conducting water to the factory, and, where practicable, also for fluming the cane. These operations would surely consume the entire alcohol output. Should there still be a surplus some of it could be used in the manufacture of ether, which is now imported into the Islands. Moreover, the residual alcohol could be marketed at a profit for other purposes.

Apart from the production of alcohol, carbon dioxide can be produced, which is of value, both as a commercial product and as a necessary reagent in the manufacture of white sugar. The weight of carbon dioxide produced is much less than the quantity of alcohol made, but it is sufficient to care for overliming in the manufacture of white sugar. The recovery of carbon dioxide necessitates extra expenditure and will be of value to the sugar manufacturer only if he wishes to make "plantation white sugar" for the immediate market. The waste from the alcohol manufacture, when evaporated either in the sun or by special devices, is valuable as a fertilizer. However, this waste, because of its potash content, might more profitably be returned to the soil from which it was taken.

4. THE SOLIDIFICATION OF MOLASSES

In solidification, the molasses is evaporated in a specially constructed pan to such a density that it will solidify after discharge.

There are several ways of handling this hardened product. Formerly it was discharged into special gunny sacks which

were first half filled, then allowed to cool, and later filled. Another method is to drop the material upon a cement floor, cut it into strips with shovels, roll it up and put it into sacks. The last-named method is advantageous in that no damage is done to other cargo in shipping, and that expensive barrels are not needed.

In shipping straight molasses to places where a good price is obtainable, the Negros planter is handicapped by the cost of containers and by the shipping distance. Small quantities are being transported in tank ships to the new distillery in Iloilo.

When molasses is sold for 5 centavos per gallon, as has been done, the buyer has no guarantee as to the available contents. Of course, contracts are made, stipulating a minimum content of solids for the molasses, expressed as Brix. However, a true basis of value—one that would give satisfaction to both buyer and seller—is the total sugar content, for which 52 per cent may be chosen as a good standard. Only the total sugar content determines the value of the molasses to the distiller. If the molasses is to be used for cattle feed, an expression of its nutritive value should form the basis of valuation. I fully understand that at first it will be difficult to convince the average distiller of this necessity; but, eventually, all distillers will have to use more scientific methods in their plants.

Further, solidified molasses can be used by possible buyers for any purpose for which ordinary molasses is used.

If a plant for solidifying molasses were erected near a shipping point such as Pulupandan, Negros, and run coöperatively by all centrals interested, shipping would be facilitated, and dependence upon the Manila or the Iloilo markets avoided by shipping direct to the Pacific Coast or to Europe, as is now being done with sugar. Some of the smaller centrals, now going out of existence because of the competition of the larger ones, could then use their evaporating plants and pans for solidifying molasses.

Relative to this subject I herewith give a free translation of an article by Beumer,[3] as follows:

> Since the possibility exists of a renewed demand for solidified molasses, and since a few factories have already closed contracts for the coming season for its delivery it seems timely to give some information as to its manufacture.

[3] Beumer, A. H. T., Archief. voor de Suikerindustrie in Nederlandsch Indië 27 (1919) 932–936.

There are still factories that do not feel justified in making this product, due to the cost of manufacture and the care that must be exercised; also because the possibility exists that the product may be refused, or that it may have to be sold for as much as 20 centavos a picul less than the price agreed upon. Even at the reduced price the factories are usually glad to get rid of the sticky stuff.

At the same time, no by-product of the sugar factory has been so neglected, while as a matter of fact no other product is so easily manufactured, and even so low a market value as 48 to 52 centavos per picul would warrant its manufacture. However, the manufacturer who contemplates starting in this business must first abandon the idea that his old pans, etc., which are no longer fit for the manufacture of sugar proper, constitute all the equipment he will require in the new enterprise.

To begin with, he will need a first-class vacuum pump, one that will give a vacuum of at least 69 centimeters. If there is no such pump on the grounds, or should its purchase be considered unnecessary, troubles are bound to result and disappointment is sure. It is better to sell the molasses in liquid form than to try to solidify it without a good pump.

Preferably a separate pump should be used for the molasses pan, for the following reasons:

(1) To obtain a constant vacuum not influenced by the opening or shutting of the valves on the other pans.

(2) Because the vapors attack the walls of the juice catchers and pipe lines to such an extent that cases have occurred in which after two seasons these had to be replaced. If this happens when a separate pump is used—and it is less likely to occur when a high vacuum is maintained—it will be necessary to repair only the line for the molasses pan; while, otherwise, perhaps the whole piping system for the central condensation would have to be repaired or even renewed.

The best way is to insure a connection between the vacuum line for the molasses station and the other pans, but separated by a tight-shutting valve or a blind flange. This plan offers the advantage that, if the central pump breaks down, the material can be worked off in the pans with the other vacuum pump, though obviously that process is bound to be slow.

The pan itself must be a coil pan, in which the coils are neither too close together nor too close to the wall of the pan. This will facilitate discharge and will give better circulation.

If both pump and pan conform to these specifications, one can be sure of a good product, and the total time of boiling should not exceed between six and seven hours for a strike of 135 hectoliters, inclusive of cooling.

Water circulation in separate iron coils is then unnecessary, and even undesirable, since the iron coils harm the circulation between the steam coils.

Boiling can be finished in five hours, if necessary, with live steam, and it is recommended that the finished molasses be allowed to cool for from one to two hours under vacuum. A pan with a capacity of 135 hectoliters is sufficient for a grinding capacity of 14,000 piculs[4] of cane, and will handle all the molasses, taking into account the time required for

[4] The Javanese picul is about 1 pound less than the common Philippine picul.—H. J. C.

dropping the strike and refilling. This then means that three strikes can be obtained in twenty-four hours, resulting in an effective pan capacity of about 65 per cent.

With a good installation no expensive supervision is required. Several factories have changed from Chinese to Javanese sugar boilers at about f15.00 [5] per month.

One of the best grades of solidified molasses was seen at the Krian Sugar Factory where one of the head sugar boilers supervised the molasses station. The vacuum maintained in this place was 71 centimeters (mercury vacuum meter).

When a manufacturer starts to make solidified molasses with his poor, outworn apparatus, he usually meets with disastrous results, especially when the market is low. Then he will resort to various methods for the purpose of marketing the product, anyway; such methods, however, do not prove profitable. The principal tricks tried are:

1. Adding milk of lime during boiling. This never improves the product; on the contrary, it makes the solidified molasses even more hygroscopical than it would be without lime.
2. Water cooling. Some benefit results from this expedient. A more intensive cooling is obtained in the pan and, therefore, there will be less foaming in the containers later.
3. Dropping the strike on a cement floor and, therefore, not discharging directly into containers. The molasses is allowed to spread over the floor to a thickness of about 6 to 7 centimeters. After cooling it is cut with a sharp shovel into strips, which are afterward rolled up and put into the containers.
4. Filling the containers about half full and filling them up later from a following boiling.

As already stated, these tricks only lead to disappointment, the chief object being to prevent foaming in the containers. This causes a red coloration of the product, and also causes the contents of the full containers to be under weight.

Containers.—As is well known, the solidified molasses is shipped in sacks (made of buri or other light material) containing a maximum net weight of 1.5 piculs while 1 picul is the minimum weight allowable.

With the containers used at present no fear need be entertained that the net weight would not be at least 1 picul if the product is of good quality; more than the maximum weight is usual. It is important that the containers be well filled, since if they are not trouble is often experienced with the buyers. Good quality product sinks well into the sacks, and filling up is never necessary.

The "glangsiemat," which is a special variety of sack made of a material like rough straw, has a special bottom, and at the top is a loose piece of the same material to cover the solidified molasses.

If rattan is to be used it will be better to buy round rattan and split it, as the commercial split rattan is often of a bad quality and breaks easily. The rattan should be soaked in water the night before using.

[5] In the Philippines the wages would be about 40 pesos per month.—H. J. C.

The use of bagasse to fill up the container often causes complaints from the buyers, and it is better to fill up with loose pieces of solidified molasses.

Production cost.[6]—The net weight per container is assumed to be 1.40 piculs. The total cost, at 36.5 centavos per picul, comes to about 50 centavos per container.

Assuming that a factory has a capacity of 14,000 piculs of cane, or an average of 300 piculs of solidified molasses, and that there are needed one sugar boiler at 1.50 pesos per day; two helpers at 80 centavos per day; for the weighing, one capataz at 1.00 peso per day; and six men at 80 centavos per day, then the expense per day is 8.90 pesos, or roughly 2.96 centavos per picul for wages, and therefore solidified molasses could be made at a cost of 39.46 centavos per picul. This figure does not include cost of fuel, maintenance, depreciation, and transportation to the harbor.

Assuming the cost of fuel to be 5 centavos per picul, then the production cost comes to 44.46 centavos, exclusive of the other items mentioned above. Cost of transportation, especially, will vary for the different factories—it is less in the Philippine Islands than in Java. Nevertheless, at a market value of 60 centavos per picul, the manufacture of this product would still be profitable.

I wish to call particular attention once more to the fact that good results can only be obtained with proper installation in which the most important factor is a vacuum of at least 69 centimeters. If such a vacuum cannot be obtained, it would be wiser not to make this product.

This whole paper contains nothing new, but since troubles are continually found with this manufacturing process, it may prove of value to those interested.

An analysis of this material is as follows:

Brix	104.9
Solids	99.8
Polarization	40.4
Apparent purity	38.5

From this analysis it will be seen that the resulting material is about one and a quarter times as compact as the original molasses, which has a Brix of about 80°.

At a value for molasses of, say, 5 centavos per gallon at the factory, the value per picul, or 12 gallons, would be 60 centavos; due to concentration 15 gallons per picul would be required, which would bring the value up to 75 centavos per picul. This does not take into consideration the ease of handling and shipping, as compared with the unsolidified product.

5. THE MANUFACTURE OF CATTLE FEED OR EASILY TRANSPORTABLE MOLASSES

It is a well-recognized fact that molasses is a valuable cattle feed. Animals have to get used to it, but like it once they are

[6] Adapted to Philippine Island methods.—H. J. C.

compelled to eat it. In Hawaii a certain quantity of the molasses is being fed with cane tops to the plantation horses, but this use of it alone is not sufficient to warrant its utilization as horse feed. In Negros also it is used for this purpose, but here again the molasses cannot all be used up. A market must be found for it.

From the standpoint of the central, it would appear to be a good plan to work all of the molasses up into the cattle feed called molassecuite, which is a solid product. Even if there is no sale for it as a cattle feed, molasses in this form can be easily handled, and shipped either to distillers or to others who may be able to use it. Textbooks give the method of manufacture, so that I need not repeat it here. The material can be blocked for shipment, and the amount of fine bagasse used in making it is very small, about 6 per cent of all the bagasse or, approximately, 1.4 per cent of the cane. In block form the need of expensive containers is eliminated and it keeps well if properly prepared. Prinsen Geerligs gives the following analyses of such material shipped from Java to Liverpool, analyses having been made four months after it was manufactured:

	Java.	Liverpool.
Total sugar	45.28	45.55
Moisture	15.79	15.15
Fatty substance	0.12	0.50
Albumen	2.88	2.75
Ash	8.29	8.45
Fiber	16.06	[a] 5.53
Undetermined	[b] 11.58	22.07
	100.00	100.00

[a] Indigestible fiber. [b] Digestible fiber and undetermined.

Sections 4 and 5 of this paper show that both uses discussed therein are equally well adapted to give the sugar manufacturer an extra profit, thereby reducing the cost of manufacture of the primary product. Since that discussed in section 5 eliminates the need of an extra pan, it appears to be the better of the two. The molassecuite contains 25 parts fine bagasse to 75 parts of molasses.

6. THE MANUFACTURE OF FUEL GAS

The manufacture, from molasses, of gas for illuminating or heating purposes has been tried many times; but the cost of fuel is considerable, and the resulting gas contains so much carbon dioxide and other substances that much lime is required for its purification. Furthermore, the gas has very little illuminating power. Perhaps where potash is manufactured from wood,

this utilization of molasses would be advantageous, since the wood has to be burned or dry distilled anyway.

7. THE MANUFACTURE OF SUGAR BY THE STEFFEN PROCESS, AS MODIFIED BY BATTELLE

This has been tried in Hawaii. In the process the glucose is all or partially destroyed by heating the original juice or molasses in an alkaline medium, and then handling the resulting product exactly as in the Steffen process, making saccharate, which is used partly to neutralize the juice. The method requires many changes from and additions to that used in existing raw-sugar factories and, so far as I know, has not yet proved successful in practice. The principle is correct, and I should like to see it given a trial on a large scale, in order to settle definitely the question of its usefulness. Of course, in this process a valuable material is lost, namely, glucose; and it remains for the individual centrals to decide whether they derive more profit from the sale of sugar and molasses separately or from going into the recovery process with a subsequent gain in sugar but loss of the glucose—and of the molasses, of course.

8. THE MANUFACTURE OF CHAR AND RECOVERY OF THE POTASH

The molasses is dry distilled and the resulting material leached to obtain the potash. The char is ground and used in fields. It helps heat absorption and makes a compact soil more porous. The process of leaching out the potash salts is described in any work on the manufacture of this material, and I need not repeat it here.

9. THE MANUFACTURE OF ACETATE OF LIME

This utilization of molasses has been carried on for some time in a large plant in Brisbane, Australia. The molasses is first subjected to acetic fermentation in the ordinary way. The resulting acetic acid solution is then distilled until it is practically free from acetic acid. The vapors (or the condensed acetic acid solution) are run into milk of lime, forming acetate of lime solution. This solution is evaporated to the consistence of a massecuite and is then spun in centrifugals to dry, while the mother liquid is used for the dilution of fresh molasses. The resulting material is shipped to the cordite factory at Maryborough, where the lime acetate is subjected to dry distillation to obtain the acetone, which is used as an admixture and solvent in the manufacture of cordite. I have no data as to the value of acetate of lime, and hope to write about this later, when I have better information.

10. THE MANUFACTURE OF GLYCERIN BY FERMENTATION [7]

In Germany large quantities of glycerin were obtained through the fermentation of sugar. In that country sufficient sodium sulphite was added to the fermenting liquid to produce the degree of alkalinity that would cause the yeast cells to perform their work as well as to propagate.

The test was made as follows: One kilogram of sugar and 400 grams of sulphite were dissolved in 10 liters of water. To the feed yeast there were added ammonium sulphate, sodium phosphate, and a little potassium salt. After some hours carbon dioxide was given off, and after about two days all the sugar was fermented.

The liquid filtered from the yeast cells contained water, alcohol, aldehyde, glycerin, and salts. Salts were precipitated and a good grade of glycerin was obtained by distillation. The sole difficulty was that the decomposition of glycerin caused the formation of trimethylglycol. After much experimentation this difficulty was overcome, and the process is now practicable.

It is a peculiar fact that, with a higher percentage of sulphite, the quantity of glycerin and aldehyde increases, while that of alcohol and carbon dioxide becomes less. This seems to involve a double reaction. It has been noticed that a large quantity of a neutral salt, even if reacting alkaline, increases the glycerin fermentation. Apparently a specific reaction must be ascribed to the sulphite.

In the United States the fermentation process has been made practicable by John R. Eoff.[8] The greatest quantities of glycerin were obtained from sugar solutions containing 5 per cent sodium carbonate, which is not all added at once. He found that a less quantity decreased production, and a larger stopped fermentation. Sodium hydroxide, potassium hydroxide, or borax can be used, but sodium carbonate is cheapest. The sodium carbonate was added when fermentation had well started, and as much as possible while fermentation was in progress; the earlier it was added the greater the glycerin product. To maintain yeast growth, ammonium chloride was added.

The best temperature is between 30° and 32° C.; a higher temperature caused decomposition of alcohol and glycerin, while a lower temperature decreased production.

[7] Deutsche Zuckerindustrie, May 16, 1919; see also Journ. Soc. Chem. Ind. 38 (1919) 175R–177R.

[8] Journ. Soc. Chem. Ind. 38 (1919) 176R.

The best concentration of sugar was found to be between 17 and 20 grams per 100 cubic centimeters. It was proved that after fermentation was complete 20 to 25 per cent of the sugar was changed into glycerin and the remainder into alcohol and carbon dioxide.

With soda added in sufficient quantity a thick precipitate formed, gas formation stopped, and the yeast lay dormant for a while. The precipitate then disappeared and fermentation proceeded again. Better results were obtained by adding soda in crystal form than in the form of a solution. A process used commercially is the following:

Yeast is seeded with a platinum loop into 150 cubic centimeters of sterile melon juice, and left to ferment. Of this liquid 15 cubic centimeters are then added to 150 cubic centimeters of the same sterile juice. After fermentation 75 cubic centimeters are added to 800 cubic centimeters of molasses solution (specific gravity 1.085=20.4 Brix). As soon as fermentation is proceeding strongly, 3 grams of soda ash are added and the whole shaken. After further fermentation this liquid is added to 2 gallons of molasses solution (as above) and this mixture is treated at the right time with soda ash in the same proportion as given above. When fermentation is complete the 2 gallons are added to 40 gallons of a solution made up as follows:

To 425 gallons molasses of 1.085 at 25° C., 8 pounds of ammonium chloride were added; the liquid was sterilized and brought with sterile water to original density. This solution contained 16.85 per cent of sugar (therefore purity is 82.6). Temperature was maintained at 30° C. and after five days fermentation was completed. Analysis of the liquid showed the following:

	Per cent.
Glycerin	3.1
Alcohol	6.75
Sugar	0.86

Alkalinity 3.6 grams sodium carbonate per 100 cubic centimeters.

Purification of the liquid was as follows: 3,200 pounds were neutralized with sulphuric acid, and 12 gallons ferrous sulphate solution added. After heating to the boiling point, milk of lime was added until there was an excess of lime, and the liquid was boiled by steam for a half hour. It was then filtered through a press and the press cake steamed. The addition of ferrous

sulphate and lime was repeated, and after filtration the alkalinity brought back to 0.2 per cent sodium carbonate by adding soda ash. The filtrate was then evaporated in a vacuum pan to a thick sirup, which contained between 30 and 35 per cent of glycerin.

It was then distilled, and 50 pounds of glycerin were obtained, roughly half the quantity present in the fermented liquid.

The carbonaceous ash is high, but by a second distillation a good product was obtained. The glycerin can be nitrated normally.

A second treatment with lime and ferrous sulphate will give no results, and a part of the glycerin will be lost in any case.

A production of 5.5 to 6 pounds per hundredweight of molasses may be expected by this process.

CERTAIN CARDIAC REFLEX SYMPTOMS DUE TO DISTURBANCES OF REMOTE ORGANS[1]

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Palpitation, chest oppression, and precordial distress are some of the cardiac symptoms that the laity regards as the usual indications of cardiac disease. I may venture to say that physicians are not exempt from this belief and are often disposed toward diagnosticating a cardiac affection the moment a patient describes one or all three of the above symptoms.

It is surprising to me how frequently the said symptoms are preceded by others that are physically just as troublesome and distressing, and yet those suffering from them do not consult a physician until the advent of the above-mentioned symptoms referable to the heart. The probable reason is that the laity is frequently under the impression that, in all likelihood, sudden death is the ordinary outcome in any affection in which the heart might be involved. They hear of many sudden deaths that were attributed to cardiac failure, and doubtless in many instances rightly so; but it is no less true that there are very many individuals who are suffering from symptoms seemingly of cardiac origin, and yet the most careful examination and observation fail to indicate that this organ is at fault. On the contrary, the heart is normal, while the seat of the trouble is in some neighboring or remote organ or organs that may exert some influence on the heart in various ways—sometimes by nervous connection, at other times by mechanical influences or by the presence of certain toxic substances acting either on the nervous mechanism of the heart or directly on the heart itself, and in still other instances we have the intervention of a psychical factor to explain the appearance of the cardiac reflex symptoms.

A person who has the slightest suspicion that his heart is diseased is often haunted by the fear of impending death. His mind is focussed, as it were, entirely on his heart. He not only feels and counts his pulse, but watches for the slightest symp-

[1] Read before the Manila Medical Society, December, 1916.

tom that may be attributed to his heart. If this attitude continues for some time, by some sort of autosuggestion he suffers from many imaginary symptoms and in time may become a real sufferer from the so-called brain storm.

A typical picture is that of a middle-aged married man, who came to see me one midnight, complaining of symptoms supposed to be of cardiac origin, as he had been told by the physicians he had previously seen. His symptoms were marked palpitation, chest oppression, and precordial distress accompanied by psychic phenomena of anxiety and fear of sudden death. The man was rather nervous and inhaled every once in a while from a small bottle containing ether. While in the paroxysm of his attack I examined him physically and, to my great surprise, in spite of all of his symptoms—palpitation, difficulty of breathing, chest oppression, and precordial distress—I found the heart entirely normal. There was no abnormal pulsation, the apex beat was in normal place, the cardiac outline was normal, and there were very good cardiac sounds. The pulse was not over 60 per minute; it was very regular in rhythm and fairly good in tension and in volume. The blood pressure, by the Erlanger apparatus, was 120 millimeters of mercury. On examining his abdomen I found distinct tenderness in the epigastrium, in the region of the stomach. In trying to get a complete anamnesis, I found the patient had been suffering for a long time before he had had any cardiac manifestations. There were symptoms referable to the stomach, such as nausea and vomiting occasionally in the morning; heaviness and sometimes pain in the stomach after meals; frequent eructation of gas followed by amelioration of the stomach symptoms; and later on the cardiac symptoms above referred to. His psychical symptoms did not appear until he was told that he was suffering from cardiac disease, and ever since his attacks have been growing more frequent and worse, for he realized then the supposed seriousness of his trouble.

The examination of his gastric contents disclosed a marked hypoacidity, and on X-ray examination there was marked gastroptosis. The lower border of the stomach was about 5 centimeters below the level of the umbilicus, and at the same time it was dilated. The patient was put under ordinary treatment for the stomach affection and was assured that his heart was entirely normal; he was counseled to take physical exercise. After a few weeks of such treatment the patient recovered completely.

The organs that might be affected and give rise to cardiac reflex symptoms are the gastrointestinal, the liver, and the genitalia. The probable relation between the latter and the heart is exclusively psychic in character.

The cardiac symptoms observed in diseases of the digestive organs (namely, of the gastrointestinal and the liver) must not be hastily taken as such without previous consideration of the possibility that the latter organs may be frequently affected as the result of a primary cardiac affection.

Another fact that is well established and that has been known for a long time is that dyspeptic conditions produce disturbances of the heart, especially in children.[2] The disturbance sometimes consists in acceleration, but much more frequently in retardation and irregularity of the rhythm. Similar manifestation is observed in adults, in whom, however, palpitation with tachycardia is much more frequent than bradycardia and sometimes irregularity of rhythm. These symptoms are often associated with anomalies of digestion, constipation, flatulence, eructations, and distention.

Although the primary causes of these disturbances are found in diseases of the stomach, intestines, and liver, there is no doubt that they are not due to any lesion in the abdomen, for a variety of conditions may give rise to the same sequence in the heart; on the other hand, the same cause by no means produces symptoms of equal severity in the same individual, or even in different ones. This makes it evident that the trouble lies in alterations in the central nervous system or in the intrinsic nerves of the heart itself or in both; at all events, nervousness is a very important factor in the development of these conditions.

Potain, as quoted by Krehl,[3] has stated that the abdominal diseases giving rise to cardiac disturbances are not grave in character, and Krehl entirely agrees with him. Potain further says that the milder affections of the gastrointestinal tract and of the liver are the ones that are apt to be associated with cardiac reflex symptoms. He mentions that in certain cases there is even absence of dyspeptic processes, and the mere ingestion of certain foods, entirely harmless in other individuals, is followed by the above-mentioned cardiac symptoms. He is inclined to believe in some chronic irritation of the peripheral nerves and the existence of an extreme anomaly of the nerves, either in the central nervous system or in the heart.

[2] Krehl, Diseases of the Heart in Nothnagel's Encyclopedia of Practical Medicine, 789.

[3] Loc. cit.

I cannot agree entirely with the view taken by Krehl in regard to the absence of the dyspeptic processes, when he mentions certain foods that are harmless to certain individuals and harmful to others with supposed anomalies of the nerves, either in the central nervous system or in the heart. When there is disturbance in the function of the organs of digestion, we have necessarily to admit that they are no longer working as they do in normal individuals. On the other hand, the supposition of nervous constitution, or of anomaly of the nerves in the central nervous system or in the heart, is equivalent to the admission of two preëxisting conditions—one, the phenomenon of idiosyncrasy, which is congenital in character and consequently must not be considered in such cases of cardiac reflex symptoms observed in adults; the other, some nervous affection of unknown character manifesting itself in conjunction with certain cardiac symptoms. This does not appear to be tenable and is contrary to the mass of facts and evidence we have on this question.

One important fact in eliminating the possibility that such cardiac symptoms may be due to cardiac affections is that special demands on the heart muscle, such as active bodily exercise, are entirely without evil effect and are indeed well borne.

Certain explanations are offered to establish the connection between the cardiac symptoms and the abnormal conditions in the abdomen. Krehl takes the intoxication theory as the most probable and the one most in accord with modern views. This theory still lacks foundation, for we do not know what the toxic substances are; all we know is that special forms of dyspepsia are particularly apt to bring on disturbances of heart action. Another possibility advanced by Potain is that the disturbances are due to reflexes from the abdominal organs acting on the heart through the pneumogastric nerve. There is undeniably a great similarity between many of these heart symptoms and the symptoms produced by irritation of the vagus. There are, besides, two other things that support this view. One is that irritation in a part of this nerve is especially apt to be propagated to other portions of the nerves, as has been shown by numerous observations. For example, we have the case of vagotony or marked sensitiveness of the vagus to any stimulant; secondly, other symptoms are observed after gastric disturbances, which cannot be regarded as due to anything but reflex irritation of fibers of the pneumogastric nerve—that is, reflex irritation through the lungs. Finally, the rapid disappearance of the symptoms, or distinct amelioration of them after copious belch-

ing, points toward reflex irritation. In such cases the disturbance of the heart action can be due only to direct irritation of the stomach, either mechanical or toxic in nature. It is possible that a stomach greatly distended with gas may directly affect the heart through the diaphragm, but this mode of irritation is probably unimportant, for in many cases there is absolutely no tympany of the gastrointestinal tract. I have seen, however, cases of stomach dilatation (atonic dilatation) confirmed by X-ray, in which the cardiac reflex symptoms were very prominent, that make me think that this atonic dilatation accompanied by distention was the main factor; as, once the accumulated gas was expelled by eructation, almost immediate amelioration of the symptoms was felt by the patient, in spite of the persistent dilatation of the stomach.

Anginoid pain in the precordial region radiating to the left arm and resembling in its character the pain felt in angina pectoris may occasionally occur. This anginoid pain coming in paroxysmal attacks is differentiated from true angina pectoris by the greater number of attacks experienced by the patient. In true angina the patient rarely survives many attacks, while the attacks of anginoid pain that I call spurious angina may recur many times without endangering the life of the patient. Exercise is of no importance whatever as an etiologic factor, the ingestion of food being the exciting factor, as a rule. As I have mentioned, these anginoid attacks are never dangerous, and they disappear when the affection of the stomach has been relieved.

A few words in regard to the effect of stomach diseases on the action of the heart. The pulse may be increased or decreased; it is usually increased in stomach affection complicated by fever, and sometimes when there is marked distention. This acts as a mechanical stimulant and, as it were, irritates the heart. It is usually decreased in chronic cases where, on account of the duration of the disease, there is more or less impairment of general nutrition and more or less general weakness; it is observed in ulcers and in ectasy.

Besides the changes in rate, disturbances of rhythm may occur, such as arrhythmia or irregularity of heart action, though not frequently.

In liver affections bradycardia is one of the characteristic features observed in the heart, and occasionally there is chest oppression. These symptoms, strange to say, are observed in acute cases of short duration; but in chronic cases the brady-

cardia usually disappears, either on account of the reduction of the amount of bile acids in the blood or because the heart becomes accustomed to their effect. If we take into consideration the usual appearance of gastric complications accompanying catarrhal conditions in the bile ducts, it is difficult to say whether these cardiac manifestations are the result of liver disease or of the stomach complication.

The factors that may be responsible for the production of cardiac reflex symptoms due to disturbance of remote organs may be grouped under the following heads: (1) Mechanical, (2) chemical, (3) psychic.

Mechanical factors.—The mechanical theory may be explained in two ways; either by encroachment of the distended stomach on the space occupied by the heart, or by the mechanical irritation of the nerve endings on the wall of the stomach, produced by the stretching of the wall. Mere overloading is not always followed by such symptoms; they may be present without dilatation or distention.

Chemical factors.—The chemical causes may be endogenous or exogenous. The endogenous may be toxic substances which originated in a perverted digestion, or may be certain internal glandular secretions or homones which, when present in the blood in larger amounts than normal, may disturb the heart action without necessarily causing pathological change in the organ. They may act, however, in manifold ways on the central nervous system, on the intrinsic nervous mechanism of the heart, or on the heart muscle itself.

The exogenous chemicals, like nicotin, atropin, and others, have no place here, as we are discussing only disturbances in the body itself that are accompanied by cardiac reflex symptoms.

Psychic factors.—The psychic factors are probably ultimately chemical. We have the experiments of Cannon and De la Paz [4] about the increase of epinephrin in a cat by psychic excitement, as rage, fright, etc. The subject of emotion is a complicated one.

In conclusion, no one of these factors is the only one responsible for the production of the cardiac reflex symptoms; but all or one of them may play some rôle in producing the symptoms in individual cases, and in many instances one or all of them may help to cause the cardiac syndrome designated under the name of cardiac reflex symptoms.

[4] Cannon, W. B. and De la Paz, D., Emotional stimulation of adrenal secretion, Am. Journ. Physiol. **28** (1911) 64–70.

CLINICAL OBSERVATION ON EXPERIMENTAL STARVATION IN HUMAN BEINGS [1]

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The physical changes that can be demonstrated clinically in experimental starvation are the effect of certain metabolic changes that occur in the organs of the individual or of the animal undergoing starvation.

Fasting may be partial or total. In the former no food is ingested, but the quantity of water permitted is unlimited, or else a specified daily amount is given; while in the latter, neither food nor water is taken. From the clinical viewpoint there is practically no difference, as the physical changes noted in either form are identical, differing only in degree, not in character.

For a better understanding of the structural changes in some of the organs, let me describe the features of metabolism during starvation. The elimination of nitrogenous katabolic products begins to diminish in the early days of fasting, and there will be a period, if the fasting is continued, in which the said elimination will reach a constant level. This fact apparently indicates that the protein katabolism is stimulated during the early period of fasting. Voit, in explaining this constant increase of protein katabolism, established the distinction between "morphotic" and " circulating" tissue protein in the body. The morphotic protein, or the more stable nitrogenous component of the cells, undergoes only slight disintegration in the ordinary course of metabolism, while circulating protein is largely used during the early days of fasting. The fall in nitrogen excretion in the later period of fasting is explained by Voit as being caused by a stage of metabolism in which other tissue components are destroyed in lieu of the residual and more stable morphotic protein.

When the starvation is prolonged beyond the limit of tolerance or resistance of the tissues of the body, there is observed an ante-mortem rise of nitrogenous elimination, which is a sign

[1] Read before the Manila Medical Society, December, 1916.

of impending death. This sudden rise in nitrogenous output is explained by some as having been produced by a sudden disintegration of the body cells because of the improper nutritive conditions to which they are finally subjected.[2] During the enhanced nitrogenous katabolism during fasting, there is observed a loss of weight, as the body is then living on its own tissues. The usual loss of body weight per day is on the average 1 kilogram, more or less.

My observations were made upon five individuals, one American and four Filipinos. The American was over 30 years of age, and the four Filipinos were under 30 years. The period of longest observation was on the American, who fasted for several periods during one hundred eighty-seven days. In the intervals of fasting he was permitted a liberal diet.

My observations on the four Filipinos covered a period of over three months. In all of them the form of fasting was of the mixed type. At the beginning there was a gradual diminution of the number of calories of food taken during twenty-four hours. The American, who is a physician, had previously undergone several experimental fasts in the United States, so he was more accustomed to the tests and was able to endure rather stricter partial fasting for a number of days with a limited amount of water during twenty-four hours. The four Filipinos were University students, who offered themselves as subjects for the experiment.

The system used in these experiments consisted of a general physical examination previous to the experiment, with recording of the weight in kilograms and also the blood pressure.

After the commencement of the fast, physical examination was made daily, with careful record of the results. Examination of the blood (hæmoglobin estimation and cell count) was made during the progress of the experiment, including the blood pressure. The results that were obtained from my observations are the following:

With the continuous loss of weight there were observed some distinct physical changes. There was a marked diminution of the panniculus adiposus or the subcutaneous tissue, especially in the face and abdomen. The normal relations of some viscera, both abdominal and thoracic, with the external structure was disturbed. These viscera are the lungs and heart in the thorax, and the liver, spleen, and intestines in the abdomen.

[2] Hawk, in Modern Medicine, Lea & Febiger, Philadelphia 2 (1914) 606.

The lungs during absolute starvation yielded a hyper-resonant or vesiculo-tympanitic percussion note throughout, probably due to marked loss of water in the lung tissue.

The heart was diminished in outline in both diameters, due either to the increased resonance of the lungs, which may possibly affect the area of dullness of the heart, or to a diminution in size of the organ through the loss mainly of water and partly of the pericardial fat. Other observers speak of a very slight change in the size of the heart, and they believe the organ is scarcely affected by starvation, in the sense that its size is but slightly diminished. Should this be the case, slight diminution ought not to be followed by distinct contraction of cardiac outline. My findings, however, give such diminution. Probably the vesiculo-tympanitic sound detected in the lungs in this case may have to do with the apparent contraction of cardiac dullness.

There was a lowering of blood pressure of from 10 to 15 millimeters, and the pulse was slow—from 10 to 15 beats less than normal—volume large, tension low, rhythm regular. The red blood cell count was below normal, hæmoglobin normal. There was, however, a distinct decrease of leucocytes, about 4,000 being found per cubic millimeter.

The liver was distinctly diminished in outline by percussion. The upper boundary was on the level of the upper border of the sixth rib, and the lower one about 3 centimeters above the costal margin.

The spleen was also diminished in size by percussion. The most probable explanation of this diminution in size is due, on the one hand, to loss of water in the liver and spleen tissues, giving rise to actual diminution in size of both organs; and, on the other hand, the adventitious vesiculo-tympanitic note of the lungs may have something to do in exaggerating the said diminution.

On inspection of the abdomen the peristaltic movement of the intestines was distinctly seen, with borborygmi at times, felt by palpation.

There is a sweetish odor, like that of acetone, to the breath.

For the sake of comparison I shall quote an experiment of prolonged fasting carried on very recently in the National Nutritional Laboratory in Boston, by Benedict.[3] The length of the fast was thirty-one days.

> The subject * * * took only 900 c. c. of distilled water a day by mouth. He lost 13.25 kg., which was 21 per cent. of his normal weight.

[3] Prolonged fasting, Journ. Am. Med. Assoc. 65 (1915) 956.

This is in accord with the results of other fasts. Succi lost 25.6 per cent. of his body weight in a forty-day fast. A dog fasting 117 days lost 62.9 per cent. of the initial weight. He was fed, regained his original weight, starved 111 days, and lost 53 per cent. of his weight. Luciani, who controlled the forty-day fast of Succi in Florence, has assumed that there is a mathematical relationship between the loss per day and the length of the fast. Benedict, however, has shown that this does not hold for human beings. He regards the weight loss as due to two factors: First, tissue is oxidized to supply material for a maintenance of body activities. Second, there is a loss of preformed water, that is, the water in the oxidized tissues. This water is lost more rapidly during the first days of a fast because there is greater tissue disintegration. This metabolic activity decreases for the reason that the subject becomes less inclined to do muscular work; he conserves his energy. He even clothes himself more heavily in order to preserve the body heat. Weight loss during a fast is decreased by the drinking of large amounts of water. It has been assumed that this water acts as a nutrient and spares the tissues. It is surprising to note that the loss of water as insensible perspiration, in Benedict's subject, varied between 371 and 691 gm. per twenty-four hours. In an individual on a full diet, this amount is much higher.

The Berlin investigations on Cetti, a professional faster, describe the "irritable heart of fasting."[4]

The pulse rate is supposedly much increased on even slight exertion. Benedict's work does not confirm this. On the contrary, the amplitude of the pulse rate, that is, the difference between the pulse rate at first as compared with the rate when active, became less and less as the fast progressed.[5] Accompanying this was a progressive decrease in the blood pressure, a maximum fall of 30 mm. of mercury resulting. There was also an actual decrease of 3 cm. in the width of the heart. These findings have been reported in other investigations, and are probably due to a decreased peripheral resistance.[6] When, at the conclusion of the fast, food is again taken, the usual pulse amplitude returns and the blood pressure soon rises to normal. From this work it is claimed that the pulse rate may be used as a legitimate index to metabolism.

Numerous changes have been reported as occurring in the blood of fasting subjects, among these a marked increase in the number of red cells. Benedict found chiefly an early rise of polynuclear leukocytes, and an increase in the blood acidity. The leukocytosis is apparently of little importance, since the leukocytes are the most sensitive of the blood cells, and respond to such stimuli as a meal or a cold bath. Their number fell to normal after the first few days of the fast. The blood acidity, from a study of the alveolar air, was found to increase markedly on the second and again on the fourteenth day of the fast, and remained at this high level throughout.

[4] This was never observed in any of my cases; on the contrary, there was sluggishness of the heart action as is shown by the diminution of pulse rate per minute during the progress of fasting.—A. G. S.

[5] My results are like those of Benedict on this point. After slight exertion the ordinary reaction, manifested by a rise in pulse rate, is lacking during fasting.—A. G. S.

[6] I have already mentioned the explanations that I am inclined to give for such diminution in cardiac dullness.—A. G. S.

When the fast was broken, it fell to normal. The hemoglobin and the total quantity of blood remained constant.

During the first days of the fast, more heat came from the glycogen that was burned than from the protein so used. Since glycogen burns most easily, it was rapidly drawn on and the available supply quickly depleted. From the first to the third day, from 10 to 16 per cent. of the heat was derived from glycogen. From the third to the thirteenth day, from 1 to 3 per cent was so obtained. The combustion of glycogen ceased after this time. As one would expect, fat eventually becomes the chief source of heat. In normal catabolism, fat is burned completely the end products being carbon dioxid and water; but in some pathologic conditions and in inanition, fat combustion is defective, and certain partially oxidized substances known as acetone bodies are produced and excreted chiefly in the urine. The clinical significance of this phenomenon is well known. These acetone bodies were present in the urine throughout the latter part of the experiment. The concentration of alkali necessary for their combustion greatly exceeds that which can be tolerated by the body.

Indicative of the so-called acidosis that occurs during starvation, besides the acetone bodies, the urine contains a large number of organic and inorganic acid radicals. Thus chlorin, phosphorus pentoxid, sulphur trioxid, and oxybutyric and other fatty acids are found. An albuminuria with hyaline and a few granular casts may also occur, but clears up after the fast is broken.

From a study of the oxygen consumption, the carbon dioxid excretion, the pulse rate and the temperature, one may conclude that there is a parallelism between these activities and the metabolism, and that the body acts as a unit irrespective of its state of nutrition.

With the foregoing results there are certain thoughts that force themselves as a corollary to our observations. Knowing the changes that occur after starvation, it is but logical to suppose that in certain diseases of long duration, mainly those on which the incidence of inanition is a necessary sequela or a concomitant condition that may arise therefrom, the train of pathological phenomena known as morbid anatomy of such diseases must be associated with those that are rather the effect of inanition. Now the question that suggests itself is: Are all of the physical findings on examination, ante- and post-mortem, the result of the disease per se, or are they accompanied by those that are produced by inanition, if it accompanies the disease? In spite of our knowledge of the morbid anatomy of many clinical entities, as well as their physical manifestations during their course, there still remains a little probability that this may have a part in the making up of some of the symptoms, physical findings, and morbid anatomy of many diseases in which there is a greater or less degree of starvation accompanying the course of the disease. Going a little further, some of the complications and sequelæ, while not directly caused by starvation, might in-

directly be influenced by it. Should this be the case, it is not pretentious to predict that the more we become acquainted with the actual changes that occur in starvation, the more we shall have to correct our views regarding the morbid anatomy and the clinical manifestations of certain diseases. We have to draw a dividing line in describing the clinical and pathological manifestations by establishing those that are the result of starvation and those that are the effect of the disease itself, just as we have to distinguish the ante-mortem changes produced by disease from those that are the result of post-mortem changes.

The final solution of the problem lies in the domain of chemical pathology, which still is sadly neglected. There is hope, however, that this branch of medical science will become one of our greatest assets.

REVIEWS

The Medical Report of the | Rice Expedition to Brazil | by | W. T. Councilman, M. D. | and | R. A. Lambert, M. D. | from the school of tropical medicine | Harvard University | Cambridge | Harvard University Press | London | Humphrey Milford | Oxford University Press | 1918 | Cloth, i–vi + 3–126 pp.

The Diseases | of Infants and | Children | by | J. P. Crozer Griffith, M. D., Ph. D. | [6 lines of titles] | with 436 illustrations | including 20 plates in colors | Volume I, pp. 1–885 including index | Volume II, pp. 1–657 including index | Philadelphia and London | W. B. Saunders Company | 1919 | Cloth, $16 net.

PREFACE

It has been the effort of the author in the following pages to present a review of the subject of medical pediatrics, as complete as seemed desirable without attempting to make it encyclopedic. Inclusion is made of such subjects in surgery and the special branches with the recognition of which physicians treating the diseases of children should be more or less familiar. While endeavoring to embody the results of his own experience through many years of contact with disease in children, he has also made free use of the numerous excellent text-books on the subject, including the valuable contributions by American authors, and of home and foreign pediatric journal-literature. To all these authors he would here acknowledge his indebtedness.

In the course of his own reading he has found quotations from medical authorities of much impaired service unless accompanied by references to the places of publication, thus rendering possible the consulting of the originals. With the feeling that others may share this sentiment, he has in footnote form given the references to literature whenever such quotations are used, believing that in this way the value of the book to many readers would be increased, while the footnote method interferes in no way with its usefulness to those others who are not interested in this line of research.

Temperature-charts and photographic and other illustrations have been reproduced freely, generally accompanied by brief synopses of the histories of the cases, without which their value would be much lessened. These are orginal or unpublished ex-

cept in the instances where none such were obtainable, or where superior ones were found in the publications of other writers. Acknowledgment has naturally been made in every case.

Throughout the text-book the metric and the English systems of measurements have been used together, putting in parentheses in the terms of one the equivalents in the other. The statistics quoted from any author have been given in the system employed by him, and the corresponding figures in the other then placed in parentheses. The equivalent values are largely those found in the tables of the United States Pharmacopœia. Ounces are respectively avoirdupois or liquid measure, except in designating the doses of solid medicaments, when Troy ounces are used. Fractional amounts in grains, drams, cubic millimeters, cubic centimeters, and grams are omitted unless the quantities are small. Grams are assumed to be the equivalent of cubic centimeters, ignoring the specific gravity of many liquids, where the figures as given would not be absolutely correct. In the parentheses the abbreviations designating grams and cubic centimeters are omitted, the sense of the text making them unnecessary. An exception to the employment of both systems of measurement will be found in discussing the preparation of food in the artificial feeding of infants. Here only English measures are given, since the preparation must be made in conjunction with the graduated nursing-bottles and the liquid measures in common household use.

Numerous cross-references will be found throughout the work, thus calling attention to discussions of the subjects on other pages, which would otherwise be overlooked unless the index were consulted. Although every effort has been made to avoid inaccuracy of statements, and particularly of references, the author must expect to share the experience of others, that these will creep in to some extent.

The author has waived his own preferences in the matter, yielding to the desire of the publishers for uniformity in the system of spelling and of punctuation adopted throughout the numerous works upon medical subjects published by them.

The | Medical Clinics | of | North America | November, 1919 | published bimonthly by | W. B. Saunders Company | Philadelphia and London | Paper, pp. 551–847, $12 per clinic year; cloth, $16.

The Mayo Clinic Number, Volume III, No. 3, contains the following papers:

Report of a case of retinitis circinata associated with tuberculosis, by W. L. Benedict.

Facial paralysis, by H. W. Woltman.

The chemical and physiologic nature of the active constituents of the thyroid, by E. C. Kendall.

The value of the basal metabolic rate in the treatment of diseases of the thyroid, by W. M. Boothby.

The preoperative treatment of hyperthyroidism, by F. A. Willius.

A case of cardiospasm with dilatation and angulation of the esophagus, by P. P. Vinson.

Mediastinal affections in childhood, by W. S. Lemon.

Differential diagnosis of mediastinal affections, by W. S. Lemon.

Myocardial disease with reference to the subendocardial myocardium, by F. A. Willius.

Dietary instructions, by D. M. Berkman.

Syphilis of the stomach: Report of a case, by T. B. Eusterman.

Pancreatic carcinoma, by R. D. Mussey.

Retroperitoneal tumors: Report of two fibromyomas, by J. A. H. Magoun.

The treatment of carcinoma of the uterus by radium, by Leda J. Stacy.

Radium therapy in cancer of the prostate, by H. C. Bumpus.

Renal absorption with particular reference to pyelographic mediums, by E. H. Weld.

An instance of primary portal thrombosis, by W. W. Bissell.

A report of fifteen cases of erythremia, by H. E. Marsh.

Aplastic anemia, by A. Archibald.

Tuberculosis of the spleen, by H. Z. Giffin.

Two patients with pernicious anemia alive more than three years after splenectomy, by T. L. Szlapka.

Some data on the range of life of transfused blood-corpuscles, in persons without idiopathic blood diseases, by Winifred Ashby.

Blood transfusion: Indications for its use; methods of selecting donors; and a brief consideration of technic, by A. H. Sanford.

A case of early lepra, by John H. Stokes.

Solitary cutaneous nodular recurrences as aids in the diagnosis of obscure visceral syphilis, by John H. Stokes.

Three cases illustrating the diagnosis and treatment of syphilitic involvement of the nervous system, by John H. Stokes.

The etiologic analysis of a chronic urticaria following influenza, with comment on treatment, by John H. Stokes.

Interstitial keratitis in heredosyphilis following influenza, with comment on treatment, by John H. Stokes.

The protection of the kidney in intensive antisyphilitic treatment, with special reference to the influence of dental focal infections, by John H. Stokes.